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Forthcoming Events.

JANUARY 15.

Junior Institution of Engineers:—Ordinary meeting in London. "The Commercial Side of Foundry Work," Paper by J. Wolstenholme.

Institute of Metals (Swansea Local Section):—Meeting at Swansea. "The Wire-drawing Process," Paper by Professor F. C. Thompson, D.Met., B.Sc.

JANUARY 16.

Institute of British Foundrymen (Birmingham, Coventry and West Midlands Branch, Junior Section):—Ordinary meeting in Birmingham. "My American Experiences," Paper by J. E. Fletcher.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "Factors that Constitute Problems in the Iron Foundry," Paper by S. G. Smith

Swansea Technical College Metallurgical Society:—General meeting at Swansea. "Some Methods of Testing Sheet Metals," Paper by Capt. L. Taverner.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.
Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Foundry Conditions and the Committee on Industry and Trade.

The Report published elsewhere in this issue of the evidence submitted by Mr. John King and his colleagues on behalf of the National Light Castings Association to the Committee on Industry and Trade is of great interest to the foundry as an invertebrate whole. It will be remembered that this Committee was set up about two years ago to solve, if possible, the much-debated question as to what is wrong with British industry. The Committee is expected to report about next September. Already evidence has been taken from the mining, the steel, the engineering industries, and it may be presumed that the N.L.C.A. evidence will be taken as representative of the foundry industries. Unfortunately, this is not the case. The light castings industry has not experienced adverse trade conditions for many years owing to the housing shortage, whereas practically all other large sections of the industry have been badly hit for considerable periods since the war in varying degrees of intensity. We agree with the evidence that if there should be a real trade revival there will be a definite shortage of moulders.

With reference to foreign competition for castings, this is generally more severe for the lighter work, as Britain can usually compete in the heavier lines, as the distances to be hauled for both raw materials and finished products are considerably shorter than on the Continent. Unfortunately some of this advantage has disappeared since the war because of the increase in British railway charges.

It was with a certain amount of pleasure we read that a standardised system of costing had been devised and a department specially equipped for instituting this in members' works. If the Association could be induced to publish this system we feel sure that it would be an incentive for all the various components of the foundry industry to take an interest in the question, its greatest bugbear, as it involves guesswork quoting. We note that the evidence states that low prices are being obtained for light castings for the home market. The German foundry cartel experienced the same conditions, but by perfecting their organisation and giving the greatest publicity to their costing system they have in most cases convinced the large buyers of castings—the railway companies and Government Departments—of the fairness of their costing system. It will be remembered by those who visited the Düsseldorf Exhibition that the German Association published a chart of the actual ascertained costs of four works turning out totally different kinds of castings, and plotted almost truly in the middle of the four curves was the cost as derived from the institution of the standardised system. The attitude adopted by the German Association amounts to this: If you can show us a fairer system of costing than the one we have standardised we will adopt it. We hope that in order to impress the Committee with the importance and magnitude of the foundry industry, that evidence similar to that given by the N.L.C.A., especially the light steel castings industry, will be forthcoming from other sections of the industry.

Book Review.

Le Laboratoire de Chimie d'une Fonderie de Fonte [the chemical laboratory for the iron foundry]. A brochure published by the Committee on Analytical Methods used in connection with cast iron established by the Association Technique de Fonderie, 15, rue Bleue, Paris IX.

So far as we are aware, this brochure is not for sale, but we feel sure that the Association Technique de Fonderie will send copies to chemists in British foundries at a reasonable cost.

The first section is very commendably devoted to the important subject of sampling. The notions enunciated are much the same as are practised in Great Britain.

This is followed by a detailed description of the estimation of the common elements in cast iron, starting off with the combustion method of determining carbon. The well-known Eggertz method is then detailed. The determination of silicon and phosphorus are lumped together, owing to the necessity of separating the former element. The method for determining the phosphorus is new to us, as the actual phospho-molybdaté precipitate is burnt off and weighed. When we were engaged in laboratory work it was customary either to titrate or convert to lead molybdate; or to wash off and dry.

For the estimation of sulphur, the evolution method is given. We were never enamoured of this method, as hydrochloric acid often fails to break up some of the complex carbides and a low result is given. Though the barium chloride method takes up much time, it is infinitely more reliable.

For manganese, both the persulphate and the arsenious acid methods are given.

The installing of a chemical laboratory is the subject of a small section, wherein a few elementary notions are given as to the choice of position, size, equipment and the like. The ventilation of the laboratory and the question of fume cupboards is dealt with separately at some length. Much space, too, is devoted to the balance. A list is appended of the apparatus and chemicals needed to stock a laboratory using the methods which have been outlined.

The final section is devoted to exposing the rôle of the chemist in the ironfoundry.

We congratulate the Committee, which was composed of M. A. Portevin (Chairman), MM. M. Gasnier (Dion Bouton), A. Levi (Saint Nicolas), E. Ramas (the President of the A.T.F.), and L. Thomas (Citroën). We believe that most British chemists who have only a slight knowledge of French will derive some benefit from a study of this book.

Patent Specifications Accepted.

The following list of patent specifications accepted have been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full specification can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

23,373. MARTIN, P. J., and BERTELS, G. F. Decarbonisation of cast iron. Oct. 3, 1924.

30,774. BRUNE, E. H. Magnetic separators. Dec. 22, 1924.

206. LLOYD, J. H., WALTER, C. M., and PALSER, J. Muffles or furnaces for the heat-treatment of metals. Jan. 3, 1925.

10,180. POUMAY, A. Cupola furnaces. April 18, 1924.

15,609. FREEMAN, H. F. Flasks for foundry moulding. June 16, 1924.

A Correction.

Mr. Geo. Batty, of the National Steel Foundry, Leven, Fife, in a letter, points out a typographical error which appeared in column 1 of page 14 of our last issue, which should read, "The finishings, consisting of ferro-silicon and ferro-manganese, were added, and a spoon time-test taken four minutes thereafter gave a reading of 38 seconds." As printed, the figure 38 read 18.

Catalogues Received.

Cast-iron Pipes.—The monthly stock list issued by the Staveley Coal & Iron Company, Limited, of Chesterfield, for January, is now available.

Measuring Instruments.—The Blackman Export Company, Limited, of 374, Euston Road, N.W.1, in their four-page Brochure E15, describe and illustrate a series of instruments for measuring the pressure and volume of gases in restricted places, one of which is specially designed for cupola furnaces.

Calenders, Diaries, etc.

We have received the following:—

From the STAVELEY COAL AND IRON COMPANY, LIMITED, of Chesterfield—a pocket diary containing many useful tables; from JOSEPH HENRY, LIMITED, of Leeds, an everlasting wall calender; from CROFTS (ENGINEERS), LIMITED, Bradford, a tear-off monthly calender; J. STONE AND COMPANY, LIMITED, a small leather waistcoat pocket diary; from the BRITISH AND CONTINENTAL TRADERS, LIMITED, London, leather pocket diary, containing a mass of useful information for foundrymen; from WATSONS (METALLURGISTS), LIMITED, Lancaster Street, Sheffield, a leather pocket diary; from THOMAS ALLEN AND SONS, LIMITED, of Thornaby-on-Tees, leather pocket diary; from PEARSON, GARFORTH, LIMITED, Bradford, large monthly wall calender; from H. G. SOMMERFIELD, London, monthly wall calender; from the STANTON IRONWORKS COMPANY, LIMITED, Stanton, leather pocket diary, containing a large number of useful tables connected with pipes and castings; and from BRITISH PIG-IRON, LIMITED, Abbey House, Westminster, an illustrated monthly tear-off wall calender of considerable artistic merit.

Contracts Open.

Australia, March 10.—Hydraulic press and steam hammer, for the Victorian Government Railways Commissioners. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X.2692.)

Bulawayo, S.A., February 16.—Pipes, for the Municipality of Bulawayo. The Department of Overseas Trade. (Ref. A.X.2686.)

Dublin, January 21.—Iron and steel, etc., for the Great Southern Railways, Ireland. The Stores Superintendent, Inchicore, Dublin. (Fee, 2s. 6d.)

Folkestone, February 1.—Iron and steel, etc., for one year from April 1, for the T.C. Mr. A. E. Nichols, borough engineer, Municipal Offices, Folkestone.

Forfar.—Pipes, for the Corporation. Mr. H. B. Skea, engineer and manager, Gasworks, Forfar.

Kilmarnock, January 21.—Water piping, etc., for the T.C. Mr. W. Dunbar, burgh surveyor, Market Bridge, Kilmarnock.

Liverpool, January 28.—Iron and steel, etc., during twelve months ending March 31, 1927, for the Corporation. The General Manager, Liverpool Corporation Tramways, 24, Hatton Garden, Liverpool.

Liverpool.—Pumping plant, for the Corporation. Mr. J. R. Davidson, water engineer, 55, Dale Street, Liverpool. (Fee, £2 2s., returnable.)

London, January 25.—Rails, etc., for the L.C.C. The Chief Engineer of the Council, Old County Hall, Spring Gardens, London, S.W.1. (Fee, £2, returnable.)

London, S.W., January 22.—Steelwork, for the South Indian Railway Company, Limited. 91, Petty France, Westminster, London, S.W.1. (Fee, 10s., non-returnable.)

Seisdon, January 25.—Tanks and filters, for the Seisdon R.D.C. Berrington & Son, Prudential Chambers, Lichfield Street, Wolverhampton. (Fee, £5 5s., returnable.)

A Standard Cast Iron.

It is perhaps not sufficiently widely known that a cast iron of standard composition is available from the National Physical Laboratory at the cost of 21s. per bottle, containing 50 grammes. Its analysis is Si, 2.22; P, 1.14; Mn, 0.50; and S, 0.075 per cent.

The Principles of Centrifugal Casting as Applied to the Manufacture of "Spun" Iron Pipes.*

By E. J. Fox and P. H. Wilson, respectively Managing Director and Foundry Manager of the Stanton Ironworks.

There are at present six plants in the world operating M. de Lavaud's patents (under licence from the International de Lavaud Corporation, Limited), namely:—In Canada—The National Iron Corporation, Limited, Toronto; in the United States—the United States Cast-Iron Pipe & Foundry Company, Birmingham, Ala., and the National Cast-Iron Pipe Company, Birmingham, Ala. (sub-licensees of the United States Cast-Iron Pipe & Foundry Company); in Japan—Messrs. Tsuda & Company, Osaka; in Belgium—Compagnie Générale des Conduites d'Eau, Liège, and, of course, the plant at Stanton, which may be claimed to be the most modern and largest plant in existence for the production of "Spun" iron pipes.

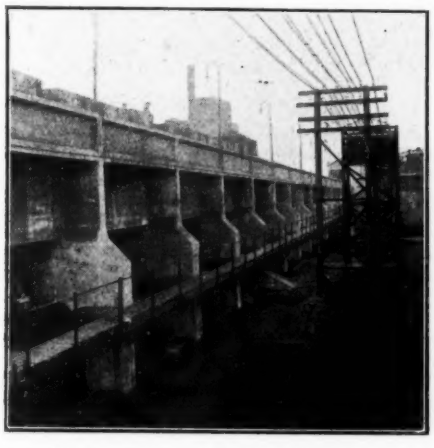


FIG. 1.—RAW MATERIAL BUNKERS.

It is proposed to consider the principles governing the De Lavaud process as manufactured at Stanton, also the finished product, "the Spun iron pipe," and the tests to which it has been subjected, also how it acquits itself under these tests. Before doing so, a brief description of the plant will be given.

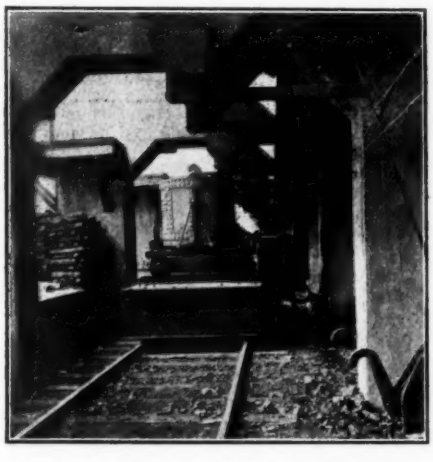


FIG. 2.—TRAVELLING CARRIAGE FOR HANDLING STOCK.

The raw materials, pig-iron, scrap, coke and limestone are discharged from wagons on an elevated railway into bunkers. These bunkers (Fig. 1), twenty in number, are constructed of ferro-concrete with steel linings, and each has a capacity of 15 tons of coke, 40 tons of coal, 100 tons of pig-iron or 80 tons of limestone. All raw materials are systematically analysed in the Company's laboratories before being discharged into the bunkers, the various grades of pig-iron being placed in respective bunkers according to the silicon content.

Travelling beneath the bunkers are electrically operated two-ton travelling carriages (Fig. 2), upon which is fitted a weighing machine. Skips are run on to these carriages, and can be put into position under any particular bunker. Special discharge apparatus at the bottom of the bunker enables the operator to control the withdrawal of the material from the bunker.

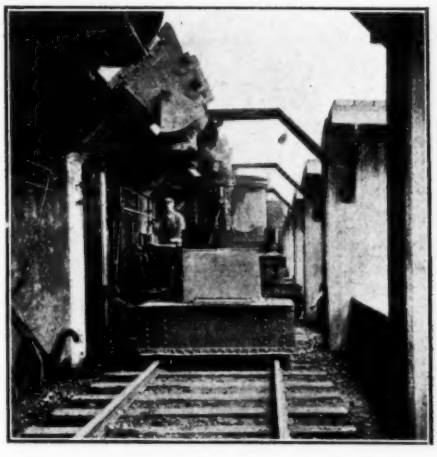


FIG. 2A.—REAR VIEW OF THE TRAVELLING CARRIAGE.

The skip is then withdrawn from the bunker carriage by an electric haulage gear, and coupled to the charging hoists, as is illustrated in Fig. 3. These hoists are hydraulically operated, the arm upon which the skip is suspended is raised to the top of the cupola. The opposite end of this arm is guided by means of rollers running on rails. These rails are so shaped that the skip is taken into the top of the cupola, when the contents are discharged automatically by bottom doors. The empty skip is then lowered to the carriage and returned to the bunkers. The cupolas (Fig. 4) are of modern design with drop bottoms, and have a melting capacity of 10 to 15 tons per hour. Blast is supplied by fans having a capacity of 8,000 cub. ft. of air per minute at a pressure of 16 to 30 in. water gauge. The molten metal is tapped

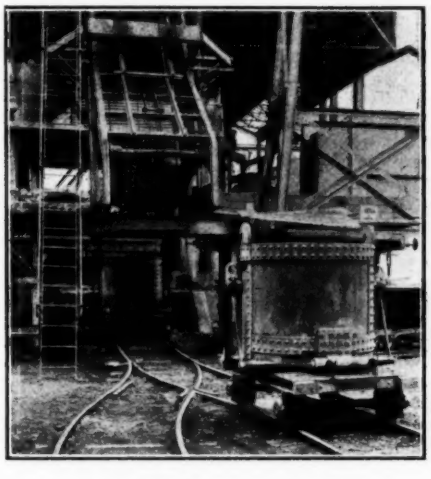


FIG. 3.—CHARGING HOIST.

* Extract of a Paper read before the Scottish section of the Institute of British Foundrymen.

into three-ton casting ladles (Fig. 5), which are conveyed to the casting shop by means of a five-ton electric crane running on a telpher runway.

The casting machine used and the processes followed have previously been described and illustrated in a Paper published in THE FOUNDRY TRADE JOURNAL in August 14, 1924, issue.

The output per man per shift is eight times greater by the "Spun" process; at the same time improving considerably the conditions under which

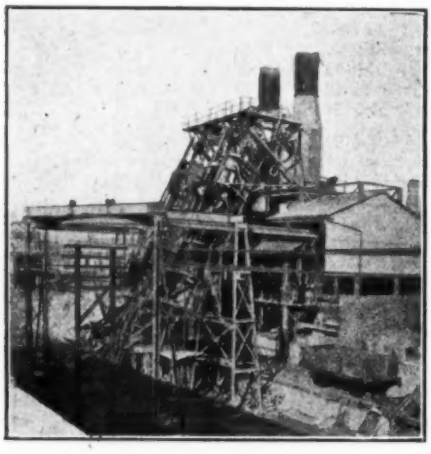


FIG. 4.—THE CUPOLA PLANT.

the worker can operate. Fig. 6 illustrates the conditions which exist in a vertical sand cast pipe pit. Further, on account of the increased strength of the "Spun" metal, which will be shown later, it is possible to effect a saving of 25 per cent. in the weight of the pipe, in consequence of the metal in the "Spun" pipe being not less than 70 per cent. stronger than that in the standard sand cast pipe.

Fig. 7, *et seq.*, show the difference in the fracture or "Spun" iron and sand cast pipes, also

FIG. 5.—CASTING LADLE FOR HANDLING THE IRON.

the micro-structure of similar metal in the two pipes at the same magnification.

Speed of Rotation of Mould.

The speed of rotation of the mould is an important factor in the satisfactory production of centrifugal castings. This speed lies between a minimum, below which the metal fails to hold up against the mould face; and a maximum which is determined by the speed capabilities of the casting machine. The optimum speed is known for each size of pipe cast, and has been found by numerous tests carried out on pipes cast at varying speeds.

Having determined the correct centrifugal force necessary to give the best results on any particular sized pipe, it was found that the ideal speed could be calculated for any size of pipe, the radius of gyration being taken at the mean diameter. It follows from this that the thickness of the pipe must be taken into consideration in arriving at the speed of rotation for pipes of various diameters. The rate of flow of the metal and the traverse of the mould relative to the spout (referred to later) have a distinct bearing on the peripheral speed of the mould.

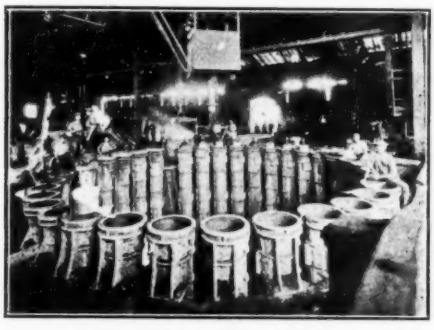


FIG. 6.—SAND CAST PIPE PIT.

That an ideal speed should exist has been clearly confirmed by Pardun,* who states:—

"Whereas up to the critical speed the centrifugal force is sufficient in order evenly to spread the band of liquid, when the critical speed is exceeded the iron begins to '*lead*' in the mould, thus causing the spirals to disappear or partially to overlap. The advancing liquid band becomes

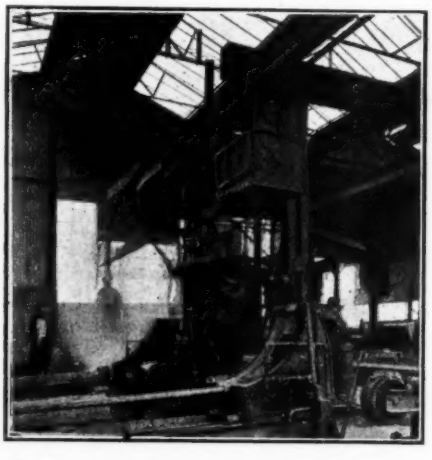


FIG. 6A.—CENTRIFUGAL CASTING MACHINE.

thinner in proportion to the amount of 'lead,' and hardens prematurely before the main jet travels over it. There is, therefore, a kind of welding effect produced.

"The phenomenon of 'lead' is caused by the fact that centrifugal force acts in two ways, namely, axially and radially. In projecting liquids the axial pressure becomes a result of the

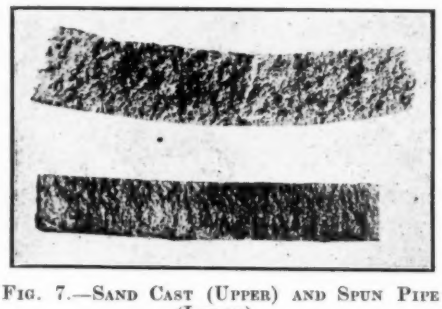


FIG. 7.—SAND CAST (UPPER) AND SPUN PIPE (LOWER).

radial pressure, the particles most remote from the point of rotation having a tendency to escape to zones of lower pressure exerted by adjacent particles. That is, these particles reach places where there are no particles already. With

* Pardun Stahl und Eisen. Vol. 44, No. 25. Translated in Foundry Trade Journal, Oct. 2, 1924.

increasing speed of rotation and consequent increasing pressure this tendency to 'lead' must increase."

Rate of Flow of Metal.

The process itself consists of the deposition of a continuous spiral of metal inside a rotating cylindrical mould. It is thus clear that to produce castings of uniform section the metal must flow at a constant rate (Fig. 10). This is achieved in practice by the simple yet ingenious design of the tilting ladle, which delivers metal at a uniform rate throughout the casting operation. Another important factor involved in the introduction of metal into the mould is the rate

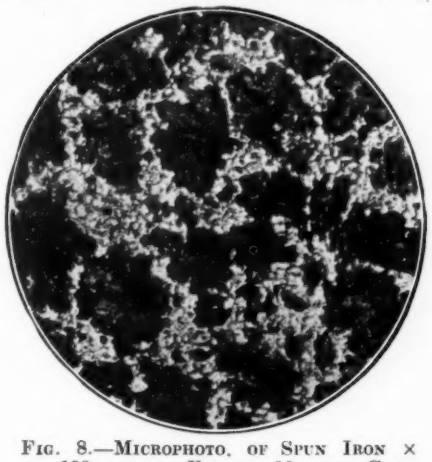


FIG. 8.—MICROPHOTO. OF SPUN IRON × 100 DIAS., ETCHED 10 PER CENT. NITRIC ACID.

of delivery from the pouring spout, and the angle at which this delivery takes place.

From experiments made in the early stages, the ideal rate of flow was ascertained, giving sufficient velocity to the molten metal to ensure a smooth deposition in the mould, and a minimum loss in temperature in the pouring spout, which is approximately 14 ft. long.

In order to maintain a regular rate of flow, the machine is so designed that the metal passes over a lip or weir giving it the necessary constant impetus. The ideal direction of flow of the metal leaving the spout would be if the tangent to the mould at the point where the metal touches it for the first time coincided with the tangent to the parabolic curve described by the metal. This is, however, in practice impossible, but the spout

FIG. 9.—MICROPHOTO. OF SAND CAST IRON × 100 DIAS., ETCHED 10 PER CENT. NITRIC ACID.

end has been so designed, and is placed in the mould in such a position as to make the angle between the two tangents very small.

Rate of Traverse.

From the foregoing remarks in respect to rate of flow it becomes obvious that the speed of traverse must be closely correlated with the rate of flow. Thus, the speed of traverse must be a constant throughout the casting process, otherwise uneven section of pipe longitudinally would result. The cross-sectional area of the trough varies according to the size of pipe made, different sizes being used for pipes from 4 in. to 15 in. dia.

The synchronising of these three movements, namely, the rate of tilting the metal, the speed of the traverse of the machine and the peripheral speed of the mould, is a very important factor in correctly deposing the stream of metal and avoiding excessive "lead" referred to above.

Casting Temperature.

In the production of satisfactory centrifugal castings it is important to observe the following conditions in respect to metal conditions:—(1) The metal must enter the mould in a truly *fluid* condition—it is essential that the metal should flow easily, otherwise the centrifugal action would be unable to exert its full effect; (2) the metal must enter the mould as a true *liquid*. The presence of primary crystals in any bulk make it impossible to secure a smooth inside to the casting; and (3) the metal must flow in an even stream down the pouring spout. Bearing in mind the small cross section and extreme length of the spout, it is clear that a sluggish metal would give an uneven flow, especially in the machines producing small pipes.

The requirements enumerated are only achieved by the use of hot metal. Excessive superheating of the metal is harmful, as excessive "lead" is

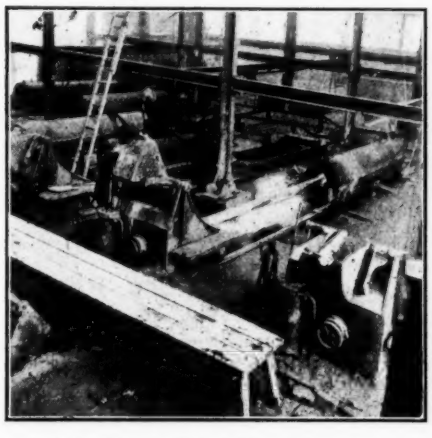


FIG. 10.—THE SPINNING MACHINE.

thereby produced. It is not usual, however—assuming normal cupola practice—to obtain a temperature which is too great.

Since the trough dimensions of the machines making pipes of large diameter are greater in respect to section of channel, and since a larger mass of metal is being dealt with, it is not necessary that the metal used on these machines should be as hot as that used on the smaller ones. In actual practice, metal taken from the cupola in the large ladle is first used for the small machines and later for the larger machines. The range of casting temperature permissible in making pipes 4 in. to 15 in. dia. is 1,200 to 1,250 deg. C.

The necessity of arranging the cupola practice to secure a clean metal can be emphasised here. Dirty metal—owing to the inability to ensure thorough skimming—gives rise to rough insides and other defects in the castings.

Numerous tests have been carried out to ascertain the physical effect on pipes cast at different temperatures. By reference to the graph Fig. 11, it will be seen that best results obtained from Stanton iron are with a temperature lying between 1,200 and 1,250 deg. C. These curves are obtained from the average of a large number of tests made on ring and bar test pieces cut from the pipes cast with metal at varying temperatures.

Metal Composition.

It will be shown that very definite segregation occurs in metal cast centrifugally; thus to ensure freedom from excessive migration of the elements the metal needs to possess as short a cooling range as possible. The ideal composition is, therefore, a eutectic melt.

In the practice referred to pig-iron of one brand is used, Nos. 3 and 4 foundry grades being supplied. On this account the total carbon of the re-melted metal is almost constant, the only variable element is silicon. It is therefore possible to control the metal by silicon content alone.

For example, using a pig-iron giving a re-melted metal with 3.5 per cent. carbon, it can be proved—neglecting other elements—that 3.0 per cent. silicon will give a eutectic melt. Extensive experiments made on pipes cast from this iron showed that excellent results were obtained with 2.95 per cent. silicon. This proves the suitability of a very close cooling range.

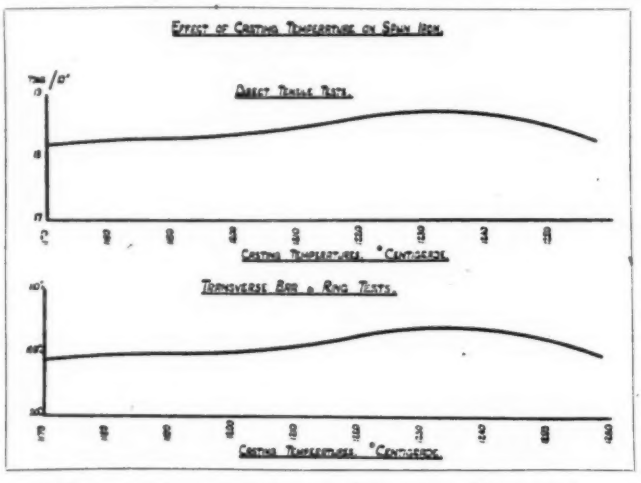

Effect of Casting Temperature on Spun Iron.
Direct Tensile Tests.
Casting Temperature, °Centigrade.
Transverse Bar & Ring Tests.
Casting Temperature, °Centigrade.

FIG. 11.—EFFECT OF CASTING TEMPER ON MECHANICAL PROPERTIES OF SPUN IRON.

Migration of Elements.

Segregation of elements in "spun" castings has been closely studied by taking successive planings from a section of pipe and subjecting them to analysis. The results are shown in graphical form in Fig. 12.

Silicon.—This element is uniformly distributed. Only substances in suspension can be segregated in the centrifugal process; no effect is produced on substances in solution. Silicon is present in the metal in solution, and therefore no migration takes place. The graphs for silicon are horizontal in each case.

Sulphur.—Manganese sulphide and iron sulphide are not soluble in Gamma iron, they possess a low specific gravity and the former has a high melting point. It is easy to realise that these compounds tend to accumulate on the inside of a centrifugal casting. The graphs show clearly the marked inward migration of sulphur.

It is remembered that no migration occurs in the extreme outer skin of the casting, owing to the quenching effect which it has undergone. With such high rates of cooling the outer layer of metal becomes solid so quickly that there is no time for any segregation to occur.

Manganese.—Such manganese as exists as sulphide migrates inwards, as described under sulphur. The residual manganese, being in solution, spreads itself evenly through the mass.

Phosphorus.—The graphs show that this element accumulates towards the outside of the castings. This is explained by the low melting points and high specific gravity of the phosphide eutectic. This eutectic operated upon by radial force exudes outwards through the solidifying mass, and since it does not solidify above 950 deg. C. it builds up on the outside of the casting just beneath the chilled portion already referred to.

Graphite.

Carbon as graphite existing in the metal during the early stages of solidification migrates inwards on account of its low density. This is clearly indicated on the graphs. Since an approximately eutectic melt is used, the migration is not considerable; it would be much more marked in carbon-rich metal owing to the rapid decomposition of primary cementite; in fact, if such a metal were used the insides of the pipes would contain a large proportion of kish.

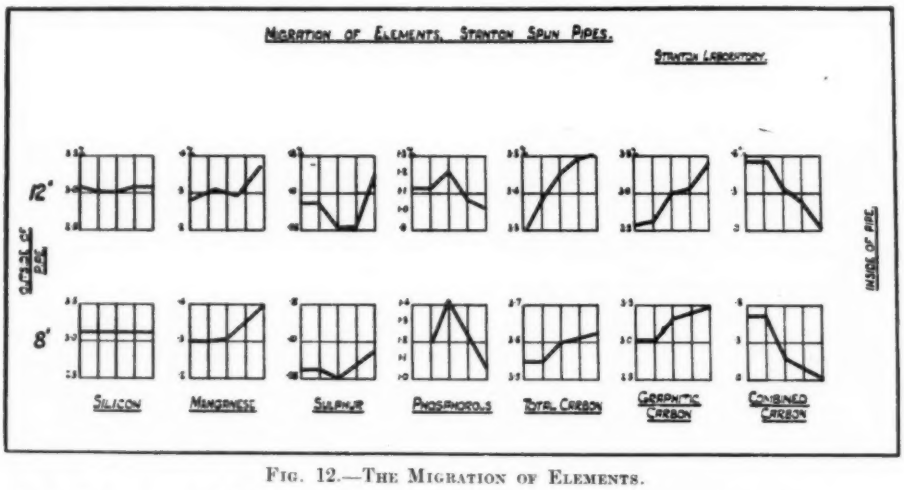


FIG. 12.—THE MIGRATION OF ELEMENTS.

Combined Carbon.

In unannealed pipes the preponderance of the combined carbon occurs on the outside of the casting. This is to be expected, as the chilling effect of the mould causes a rapid rate of cooling in this part of the casting. The rate of cooling is much less rapid as the inside of the casting is approached, and for this reason the combined carbon percentage becomes considerably less.

(To be continued.)

The Light Castings Industry.

At a meeting of the Committee on Industry and Trade, held on Thursday, January 7, 1926, evidence was submitted by the National Light Castings Association, represented by Mr. John King, President of the Association, and Mr. Scotland and Mr. Wallace, members of the Executive. The witnesses explained that the home of the light castings industry lies in Falkirk, although there were light castings foundries situated in various other parts of the country.

It was stated that relationships between members of the Light Castings' Federation and the various Trade Unions, whose members they employ, were on an eminently satisfactory basis. There were agreements covering practically every category of worker, and establishing a basis of remuneration to the workers, which bears more than favourable comparison with that of wages paid in other competitive industries of an analogous class in this country. The witnesses took no exception to the efficiency and industry of the workers, nor was it sought to advance that there was undue restriction of output. Reference was, however, made to the fact that the inelastic nature of Trade Union rules and regulations occasionally gave rise to friction on the matter of the number of apprentices admitted to the trade in its various categories, and also, in certain cases only, in regard to the working of overtime. The witnesses did not allege that there was any serious lack in the adequacy of the labour supply, except in one instance, viz., that of grinders, although it was suggested that if allied trades throughout the country became busy, the statement as to the adequacy of the labour supply might have to be qualified.

Reference was also made to the conditions of labour and wage rates in Continental countries from which competition was being experienced, the witnesses contending how substantially in favour of the foreign manufacturer were the labour and wage conditions in these Continental competing countries.

The activities of the Association in the direction of the standardisation of costs in the industry were explained, it being pointed out that the Association had a special department for dealing with this matter, and that such department, in addition to keeping statistics relating to fluctuations in details of cost, was also available for advising on the installation of costing systems in members' foundries on the lines recommended by the Association.

Tables were submitted showing comparisons between freight rates to overseas markets in 1914 and at the present day, and also between the freight rates in operation at present between Continental ports and overseas countries on the one hand and between our home ports and such overseas countries on the other hand, a decided difference in the rates being shown in favour of the Continental producer. The tables also showed the increase over pre-war of the rates from Falkirk to various ports of shipment; and the witnesses felt that, if anything could be done to reduce these charges to a pre-war level, it would have a highly beneficial effect on the export trade.

The activities of members of the Association in the furtherance of scientific research work were gone over, it being explained that it was largely due to their efforts that the Falkirk Technical Institute was founded. In this Institute lectures are given by a scientific expert, and investigations are carried out into the causes of defective castings, etc. The Association members also played a prominent part in the formation of the Institute of British Foundrymen.

With regard to the present position and prospects of the industry, it was explained that whilst the improvement in sanitary conditions abroad is creating an increasing demand for light castings, the competition from Continental competitors is becoming increasingly severe, the manufacturing conditions obtaining in these countries, and the rates of exchange, enabling them to sell at prices with which the British manufacturer cannot compete.

With reference to the home market, it was stated that whilst there was a considerable demand for light castings for housing schemes, the benefits of this demand were nullified by the low prices being obtained for these goods. In addition, foreign competition in this direction was increasing, so that the present activity in the industry was misleading. With a view to meeting foreign competition in every possible way, the light castings ironfounders were investigating and experimenting with every new method of production brought out.

Scrap in the Blast-Furnace Burden.

DR. BORMANN (of Hörde) has investigated the effect of this change in the composition of the burden on the working of the blast furnace and described the results of his investigations in a long contribution to two recent issues of "Stahl und Eisen." The following table shows, for nine experiments (1) the percentage of iron in the burden charged as ore; (2) the percentage of iron in the burden added as scrap; (3) the coke consumption per 100 kg. of pig-iron produced; (4) the consumption of limestone per 100 kg. of pig-iron produced; (5) the quantity of slag produced per 100 kg. of pig-iron; and (6) the daily output of pig-iron. The iron contents of the scrap was calculated at 95 per cent. of the weight in every case.

Working Results with Scrap in the Burden.

Number of Experiment.	Percentage of iron in burden.		Per 100 kg. of pig-iron produced.			Daily Output of Pig-iron.
	As Ore.	As Scrap.	Coke Consumption.	Limestone Consumption.	Slag Produced.	
	%	%	k.g.	k.g.	k.g.	Tons.
1	100.0	0.0	120.0	50.0	—	137
2	64.5	35.5	117.0	56.5	48.0	152
3	43.5	56.5	91.5	44.7	48.0	180
4	40.8	59.2	89.0	41.8	47.0	189
5	39.6	60.4	85.0	39.7	46.0	198
6	30.0	70.0	80.0	37.3	42.0	202
7	25.0	75.0	83.5	46.0	42.0	222
8	21.7	78.3	93.9	44.8	41.0	196
9	19.0	81.0	95.5	44.2	42.0	212

Dr. Bormann summarises the effects of adding to the burden large quantities of scrap on the working of the blast furnace as under:—

(1) Higher temperatures in both the shaft and at the throat of the furnace.

(2) Less indirect reductive capacity and higher carbon monoxide content of the blast-furnace gas.

(3) Upon the whole the addition of large quantities of scrap to the burden has had a beneficial effect on the working of the furnace. In actual practice about 30 per cent. saving in coke and an increase of up to 60 per cent. in the pig-iron output of the furnace have been attained, thus effecting considerable reductions in the costs of production of pig-iron.

(4) In consequence of the facts mentioned in (2) the blast-furnace gas has a higher calorific value and leads to further savings in the working of accessory plants.

On the other hand, adding large quantities of scrap iron and steel to the burden has the following disadvantages:—

(1) Increased difficulty in charging the scrap into the furnace, more especially if the scrap is very bulky and loose, and consequently light in weight per unit of volume; hence increase in the costs of wages of the men charging the furnace.

(2) Greater losses and increased consumption of water used for cooling, due to the higher temperatures in the shaft and at the throat.

(3) Fluctuations in the chemical analysis of the pig-iron produced due to the great diversity in the quality of the scrap used.

(4) Lower carbon content of the pig-iron produced from scrap. The difference in the carbon content, however, compared with that of pig-iron produced from ore is insignificant.

These disadvantages somewhat complicate the working of the blast furnace when the scrap forms a large proportion of the burden, but they are greatly outweighed by the advantages gained.

The Training and General Position of the Craftsman.*

By Major K. C. Appleyard (General Manager Birtley Iron Company).

Introductory.

For this Paper it must be borne in mind that, although it is read before an Institute particularly devoted to the foundry trades, it is not intended as a contribution specially directed to this branch of engineering. It enlarges upon some notes and criticisms accumulated during several years in which the author has given this subject a good deal of thought and interest, and it is offered more with a view to stimulating discussion than with the idea of making any suggestions of value. An interesting discussion can be carried on as to which among the engineering trades can be called a really skilled trade or craft. What is a craftsman? Without going into formal definitions, and for the purpose of the present Paper, it can perhaps be permitted to consider that an engineering craftsman is a highly-skilled artisan whose personal work is creative and mainly dependent on his skill, and whose work cannot be split up into a number of single operations which could be carried out by unskilled persons. If the engineering industry is surveyed in this light it is obvious that certain of the so-called skilled trades are hopefully bolstering up the idea that they *are* highly-skilled trades in face of the obvious fact that they are not, and that actually the most marked advances in certain classes of work are due to the splitting up of complicated operations into simple ones performed with fool-proof machinery by unskilled or semi-skilled workers. With the exception of certain highly-skilled workers in jigs and tool making, finished fitting and important erecting, the patternmaker, the moulder, and the smith are left as the three main examples of the engineering craftsman whose work cannot be reduced to simplicity in the way already indicated. Advances in the science of machining have steadily been reducing the fitter's capacity for being more or less independent of machines and for being able to turn his hand to any and the finest work. The same advances coupled to the development of jigs and copies are steadily tending to reduce the turner's capacity and adaptability, and the war conclusively showed that it is sometimes possible to eliminate them entirely even on very high-class work.

What may be called the mechanicalisation of trades has not dealt so harshly with the three specially mentioned above. It is true that the patternmaker's domain has been encroached on by the universal woodworking machine and several others, and that, in consequence, there are now a few pattern shops without a wood machinist, but no one has yet replaced him for his personal skill in reading drawings and generally bringing into being that which will enable the founder to produce his perfect casting, in spite of the apparent efforts of some draughtsman to ensure that it cannot be done.

The smith now has as his aid the power hammer and the electric welder, and his territory has been invaded by the drop stamp, the heading machine and so on; but outside the realm of repetition, work of fairly simple character, his skill is still the primary requirement of his trade and cannot be reproduced by machinery or split up into simple forms.

The moulder is in the same category, and, although the sandslinger may sling and the moulding machine jolt, yet must the man with the trowel and the sleeker and the muddy fingers still be one of the irreplaceable features of the foundry industry.

Fundamentals and the History of the Craftsman.

It may be interesting to consider for a few moments the history of the industrial craftsman. In the earliest civilisations the tools of production were so primitive that the output of the individual was very low, and his state of well-being low also, with the result that craftsmanship, although often wonderfully highly developed in the individual, was no release from a common slavery which supported the ancient nations. But this was true handicraft system, inasmuch as the skill of the individual worker was the essential feature of it, and there was not a dependence upon congregated effort to complete a series of operations.

In the Middle Ages men were either bound by feudal ties to the landed proprietors of the soil or were held together by the strong bond of the handicrafts guilds; the system was still an individual one as opposed to the congregated or factory system now known, and the skilled worker was rewarded by his lord or employer with the fruits of his toil, and received in return some measure of protection. With the decay of the feudal system came the domestic system, in which the craftsman was primarily an agriculturist, and relied mainly on this for his livelihood, and almost alongside this arose the beginnings of the present system, whereby an individual hired or employed numbers of men to work together in his house or shop, and sometimes to operate machines.

There followed the present system, whereby generally speaking, the worker was separated from the tools of industry, and capital was required to provide the new and complicated machinery and to provide power and finance to operate it. There has followed rapidly on this the two further stages in the degradation of skilled labour, the transfer of skill whereby the skill is transferred to the machine, which is semi-automatic, but still needs an attendant, and, finally, the transfer of intelligence, where the operator has no duty but to feed it, and the machine is fully automatic. The word degradation is used above in no objectionable way, and actually the general history outlined has brought immense advantages in well-being to all engaged in the production of useful goods.

Present Position and Future Development.

The position now appears to be that the craftsman, although perhaps not completely divorced from his tools, is resisting the steady pressure of mechanicalisation, which is accompanied by competition from lower-paid semi-skilled or unskilled labour, all of which makes an inevitable attack on his status, and consequently on his worth and standard of life. The corresponding effect on the short-trained or untrained worker is an improved status and standard of life, and the last ten years has shown the wage rates of the two classes to be rapidly approaching one another, and, in fact, the "repetition man" if often better off financially that his co-worker, who spent some of his best years in learning a trade. There is the bricklayer's labourer earning more than the moulder, the machineman more than the fitter, the tramcar driver more than the brass finisher, and the painter more than the smith. The attraction for a boy to enter a skilled trade in engineering seems, therefore, to be less; many things seem to be against it; he can make but little less as a semi-skilled man, living conditions at home are so often such that nowadays it is difficult to afford the years of apprenticeship at low pay, and any notion of the dignity of a craft tends to be educated out of him by those whose idea in life is to preach doctrines of political and industrial reformation which tend to level down rather than to level up.

Social and Psychological Factors.

It is fairly obvious, therefore, that some part of our problem is affected by national ideals and the social effects of the constant changes in our industrial system. If our ideals are to be those of the leveller down, then craftsmanship will indeed be degraded and the craftsman swamped by the hordes of those who then have it in their power to grab all that industry can give them, whether their labour be worthy of its hire or not, and we reach the stage where key trades or industries can recklessly use their positions to hold up the community for the advantage of their own small unit. Such a policy of "Pull Devil, pull Baker" can produce but one condition, and the promising men

* A Paper read before the Newcastle Branch of the Institute of British Foundrymen, Mr. M. B. Herbst presiding.

will either go to fresh countries or steer clear of the unpromising skilled trades. On the other hand there is, it is hoped, but little doubt that our national ideals look up and not down, and that as our sound national characteristics reassert themselves and readjust themselves to the changed conditions we now experience, the political and industrial revolutionary quacks will come to the end which it is understood that most swollen birds who quack come to, and that as our engineering trade revives we shall be able to take a hand in the permanent refashioning of a steadily improving order of things. But if this is to be done we have to face the fact that a new order of things has been brought into existence, and that never again are men going to be satisfied with the conditions they put up with even ten years ago, they may have to put up with them, but they will not be satisfied, and dissatisfied men are useless men from any point of view. So that in addition to national ideal and the steady change of the industrial system social and psychological questions must enter largely into consideration when dealing with the future of the craftsman and his training.

Aspirations of the Craftsman.

Many minds have sought to discover the principal aspirations of the workers, and there appears to be a general conclusion that these are:—

(1) The removal of the fear of unemployment; (2) the recognition in industry of the human status of the worker, and (3) the receipt of an equitable share of the product.

To deal with them does not come within the scope of the subject of this paper, save that when considering the general position of the craftsman and his future it must be borne in mind that these are his aspirations, it must be pondered as to what extent he is attaining them, and it must have a prominent place when discussing and planning his education and training and his future position in the engineering industries. It is not intended to suggest that all the hopes of the workers are founded by the bare words given above, but most of them can be grouped under one or other heading. The desire to invest surplus earnings in greater household comforts, clothing, holidays, etc., is bounded by the fear of unemployment, and although in these days there seems to be ample provision made for men in idleness, it is obvious that this drain on a country's resources cannot go on indefinitely, and there is little doubt that the best among the workers resent the necessity of doles and relief, and would gladly welcome permanent employment at reasonable wages, and a restoration of that happy feeling of personal independence that is very far from being lost in British national character, however much it appears to be clouded over at present.

Discontent and Progress.

Discontent is really one of the essentials of progress, and few people seem to realise that certain forms of it are desirable rather than undesirable, more particularly if they are caused by the urge to build up and progress rather than to criticise and destroy. One of the principal and proper causes of discontent is education, and much of that disturbance existing at present can be traced to the system of public education developed during the last three or four decades which has affected so completely national and industrial life. The provision of such wide facilities for free education arose entirely from a slowly increasing demand for it from the working classes, and anyone actively interested in education administration to-day knows that a similar demand is responsible for the tremendous provision now being made almost everywhere for technical education in secondary schools, all of which is good evidence of the intention of the workers to go forward and of a discontent with the state of things at any given time.

America affords reasonable proof that socialist economic theories are by no means necessary for the attainment of progressive ends, but there is to be found there an active study and understanding of the psychology of the working man, and a determination not to disregard the natural hopes for better things that are in all of us.

The only promising avenue for the ambitious man should be the skilled trades. At present these are not sufficiently attractive from the point of view of remuneration, and probably most foundrymen share a common detestation of the low rates of wages paid for skilled as compared with unskilled work. Everybody is aware of the causes of these wages and can only hope that as British world-position improves they may be remedied with the active help of the workers, by the removal of suspicion and the creation of a feeling of mutual trust between employers and employed. All this is very easily written, and is a commonplace, mouthed at many street corners, it cannot be anything but a very long task, and one which will involve an understanding and acceptance of the general ideals of the workers and a desire to help them. But having improved the financial status of the craftsman there still remains to attend to that human side of him which must also be satisfied if he is to have content in his work: the ambition which is to be satisfied; the pride which is to be encouraged; and the accomplishment which is to be rewarded by a feeling of personal satisfaction in the work done. Surely the first step in doing this is to improve the status of his craft, and make him feel that to be accepted as a member of that craft is in itself a satisfaction and an honour which he must uphold. This Institute has always appeared to be doing just that very thing, and all that is to be feared is that like so many other institutions it may drift further away from the craftsman and become the playground for scientific theories advanced by those whose work is not the actual practical work of the industry, but the scientific and administrative side of it. How many institutions are there for working men, and why should there not be many more. Masonic, brotherhood, and political lodges attract working men in numbers, why not foundry lodges, where craftsmen can meet and have a drink and talk about anything under the sun under reasonably pleasant social conditions, all the time feeling that they are only admitted to the gathering by virtue of a special skill and membership of an honoured craft. They may talk football and racing, but nevertheless there will be plenty of exchange of opinion as to why the locomotive cylinders have all been bad recently.

Influence of Visitors.

Why not open the foundry periodically, and let the men bring in their wives, and daughters, and sweethearts, and inferior brothers who are not members of the craft, and show off the difficult work that they are doing? How often does a working man's wife know what the shop looks like in which her husband works, or what his work looks like? And yet, which among us who has had the opportunity to show his own womenfolk his works and the fruits of his work, does not get some happiness from discussing those ever-present incidents of daily toil with one who is even vaguely familiar with the scene of his activities and the responsibilities he carries? In what essential is the working man different, then? Opening up the shop costs nothing, and fosters that pride in work so much desired to see. Early this year the Butley Iron Company threw open the works one Saturday afternoon, and any employee, by applying for tickets, was able to bring his friends and relations in. There were volunteers available to man the interesting machines; castings were made periodically during the afternoon, and were something interesting was happening in every shop. We expected, perhaps, 150 or so visitors, and, to our astonishment, the number exceeded 700. For days afterwards letters arrived from all sorts of unknown people, even from most distant places, expressing thanks for the opportunity to see where their friends and relatives worked. One small boy about 15 impressed the author immensely; he was leading round an old man who is his grandfather, and they were inspecting a large electric mine haulage, which was running for the benefit of the visitors. As the author was passing he threw out his chest, and said to the old man: "Yes, we made this here, and we've made some very fine ones." The "we" was specially appreciated, because this small boy had never worked in the shop in which the hauler was made. But the beginnings of pride in achievement were there, and the author went over to the old man, and backed up the small boy for all he was worth.

The whole thing was a great success, and undoubtedly strengthened the pleasant relations which exist between the company and its workers. It is possible so to arrange that craftsmen should be given every opportunity to see their work in its finished condition. How many moulders are there who have made marine engine and turbine cylinder castings by the score, but who have never seen the finished article, or even any machine work on their castings, save when the enjoyment of the machine work is tempered by the thought that the casting is a bad one, and has to be made again for half price. Again, men like to know the reasons why orders are given for changes in organisation or administration, and this very human dislike of being told to do something you do not want to do, without being told why, is often fanned into active resentment by those whose job in life seems to be the prevention of peace anywhere. It seems much easier to explain why and take everyone with you than to stand on your dignity and merely issue commands. As men get more educated they like unexplained commands less, despite the fact that the public system of education seems to attach more importance to subjects than to character and discipline.

Personal Cleanliness.

Unquestionably, character is one of the prime essentials in the craftsman if his status is to be improved. He must be a *somebody*. He is not likely to appreciate bad working conditions, drudgery and monotony, darkness and dirt. The moulder must be brought to look on his materials as a kind of clean dirt, but the time will come when he will not want to walk home looking like a dirty ogre, but will want adequate cleaning facilities at his place of work. When that time comes everybody can be thankful, and if there has been enough profit by then to provide the facilities, the owner can ease the pain of signing the cheque by reflecting that the world is getting better, and that the craftsman is coming into his own.

It may be said that the meditations put forward here are too idealistic for words, and that one cannot deal with men on these lines in these times. It is admitted that many very desirable improvements are at present economically impossible, but this must not last. Neither man nor industry is much use without ideals, and they are essential when prosperity comes again, and everybody is anxious actively to push forward to better things. The author finds it out of the question economically to practice all the things he believes in, but he still believes and hopes in them, and really very little that is outlined here costs money at all.

Choosing the Apprentice.

To get the superior craftsman, there must be some selection of the boy. There are too many unsuitably equipped boys serving their time in particular trades, and there is rather too great a reluctance, perhaps particularly in the foundries, to put them out when their incapacity has been discovered. It will take time and improved status and conditions to make the mouders' art attractive to boys. Dirt and cold are two of the reasons why. It has always seemed to the author that the first reason might be overcome by providing or encouraging the use of conveniently made overalls for apprentices, which they could shed and lock up before leaving work. Even without a wash, they would then be at no great disadvantage as compared with their machine and smiths' shop confrères, while if the wash was provided, and even insisted on, they would be equals in appearance, and this question of differences in personal appearance weighs in the minds of better educated boys rather more than is generally imagined. It would be interesting to hear the subject of overalls discussed. Cold should be dealt with in foundries as in other shops, while it is hoped that the idea that a foundry must be a dark, dingy place is going out rapidly.

Having chosen the boys, with the aid of a competent schoolmaster or some other person with a personal knowledge of their character, the next step is to teach them their trade. The spread of education has led to a feeling that employers are no longer under obligation to teach principles of trade; but in their own interests it is obvious that this must be done, and it will be better done in an organised rather than a happy-go-lucky way. It is something of a pity that often the first jobs a boy gets are menial ones, such as fagging for a journeyman, clearing up the floor or carrying the cans. It seems important to catch his interest early, so that from the start he gets the idea that he is a real maker of things. For the practical work it seems eminently desirable that there shall be a segregation of apprentices in a special department, with a sympathetic instructor well equipped in his art. Attachment to journeymen so often means that although a boy may see how a job is done he never gets the chance of doing it independently, and he acts more or less as a young labourer; this does not foster in him that urge to create things which should be the spirit of the craftsman. Given a capable instructor and a good selection of apprentices of all ages, there should be no difficulty in making any casting by their labour, not at the speed of the experienced journeyman by any means, but still the personal achievement of the young hands who are to enjoy the improved status already discussed.

Artisan Training.

Teaching young moulders theoretical work is more difficult; to start with there may be a limit to the amount which is useful or which can be readily absorbed. It will be to their advantage to take engineering evening classes, and generally absorb the principles of mechanics on which engineering depends, and it is difficult to see why moulders should not regularly use drawings, and be able to read them instead of relying on the patternmaker. The possession of this knowledge is all to the good. But to teach moulding theoretically is like bathing babies theoretically, it cannot easily be done, as they are both such essentially practical operations. Instructors, also, are difficult to find for the theoretical work, men who can convey facts simply and impressively, and who are yet practical. Again the average foundry could not afford a purely theoretical instructor or keep him occupied for more than a few hours a week, while it is only in regular foundry districts that any instruction in the art is available from public sources at evening or continuation classes. Yet the subjects of cupola practice, moulding sands, refractories, facings, metal compositions and the like do provide materials for such theoretical training, and it would probably pay companies to get together and share an instructor, while allowing the apprentice a few hours each week for the purpose of getting this additional education.

On the subject of training endless matter can be written, and the only trouble is that sufficient money is not available for such experiments to be tried out in any other than a tentative way. If, however, these comments stimulate interest and discussion their object will have been achieved.

To summarise, one may say that the status of the craftsman rose from a low to a high point over some thousands of years, and has recently been tending to decline owing to the attack of highly specialised tools and processes which simplify production and reduce the standard of intelligence required, and that the accompanying result has been the rise of semi-skilled and unskilled labour with no equal progression of the craftsman. He is still a vital necessity in engineering industry, and it is most desirable to improve his status and standard of intelligence and living. This may be done by endeavouring to understand his aspirations and psychology and to appreciate them, and by organisation tending to give him marked social privileges by virtue of his skill: by careful selection and training of apprentices: and by constantly developing character in them, particularly that pride of achievement by means of intelligence and skill which is so satisfying to the spirit of every true worker.

AT A MEETING of the Junior Institution of Engineers, held on January 1, six films were shown illustrating some of the work carried out at the River Don Works, Sheffield, of Vickers, Limited. The first three films showed the crucible melting department, the tube mill, and the bar and sheet mills, and the rest concerned the manufacture of ordnance, including the production of pig-iron and ordnance steel, the casting of ingots, and the forging and machining of a 15-in. gun.

Some Applications of Research to Modern Foundry Practice.

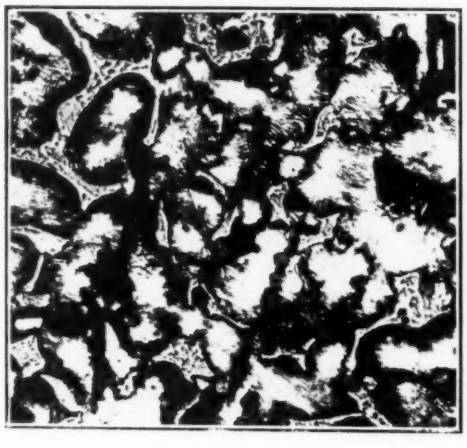
By J. E. Fletcher, of Dudley, M.I.Mech.E.

(*Continued from page 532.*)

In the micro-examination of castings, such as the one before mentioned, Fig. 3, the polished and unetched micro-specimens reveal near the edge of the casting the presence of dendritic crystals, the long axes of which are arranged normally to the cooling surfaces, or nearly so. These fir-tree-like crystals have their trunks crowded together and their stunted branches dovetail into one another in approximately regular order, enclosing within the interstices between the branches comparatively thin flakes of graphite. The depth or thickness of this columnar or dendritic envelope is greater as the silicon and carbon content decrease. In the centre of the metal mass, where the cooling is slowest, the structure is generally composed (in grey iron) of pearlite, ferrite, and large graphite flakes in confused orientation.

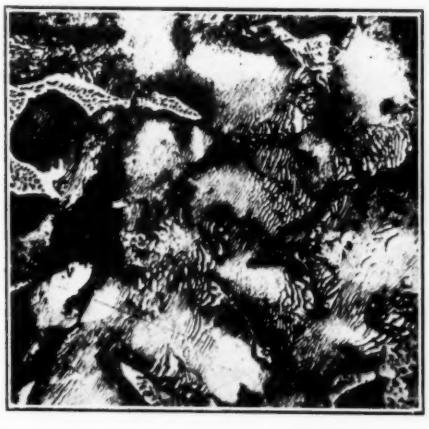
A

× 250 DIAS. PICRIC ACID.



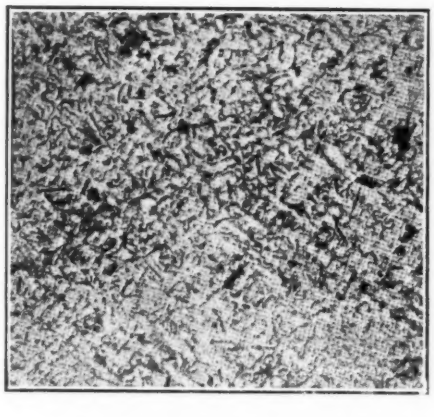
B

× 450 DIAS. PICRIC ACID.



C

× 50 DIAS. PICRIC ACID.



D

× 50 DIAS. UNETCHED.

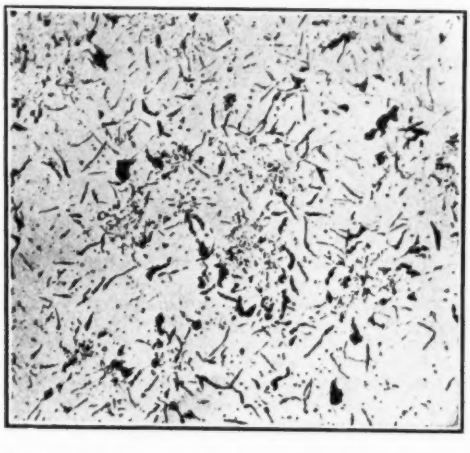


FIG. 4.—DENDRITIC STRUCTURE IN THE THIN WALL OF AN AUTOMOBILE CYLINDER. IN THE CASE OF C, THE FACE OF THE CYLINDER WAS AT THE RIGHT-HAND BOTTOM CORNER.

Fig. 4 shows such a dendritic structure in the thin wall of an automobile-engine cylinder, the two low-power unetched photo-micrographs illustrating the dendrites most clearly. In this case the metal contains about 1 per cent. phosphorus. The phosphide eutectic, the last constituent in the metal to solidify, is seen as a broken network of honeycomb-like form distributed throughout the mass. The rapid cooling has resulted in small crystals. Most, if not all, commercial grey irons are, when cast into thin walled castings, dendritic at the moment of freezing in a cold mould. If more slowly frozen in a thicker-walled casting the dendrites grow until their original outlines are lost. Unless completely pearlitised (*i.e.*, the original austenite converted into pearlite) the austenitic dendrites may retain so much of their original iron and manganese carbides that they produce a hard, brittle structure, which, though high in tensile strength, has little impact-resisting value, the presence of sulphur as sulphides intensifying the trouble.

There seems little doubt that the dendrites are the crystals which grow during the decomposition and graphitisation of the 4.3 per cent. carbon eutectic, which forms the first matrix of all cast irons, and is the major constituent to freeze, but is rapidly decomposed in presence of more than, say, 0.5 per cent. silicon. Fig. 5 illustrates the structure of the 4.3 per cent. carbon, 95.7 per cent. iron eutectic (white honeycombed plate crystals), backed by a pearlitic mass containing graphite—the product of decomposition of the eutectic.

The structure of any moderately thin-walled iron casting as cast in a sand-mould may, therefore, be conceived to consist of an envelope of dendritic crystals more or less decomposed or

pearlitised, enclosing a core of mixed crystals composed of pearlite and ferrite intermingled with graphite and phosphide eutectic, the silicon and manganese being dissolved in the matrix. In Fig. 6 the type of structure, illustrated in the form of castings made by the author from puddling furnace slag, shows the dendritic form of primary crystals enclosing a core of mixed crystals, analogous to the form of structure produced in most cast irons at the early stage of solidification. This illustration (Fig. 6) also typifies the variations in gas cavity formation as influenced by varying contours and thicknesses of walls. The defects shown have been repeatedly observed in white iron castings for malleable processes. Here the primary crystals are largely composed of 4.3 per cent. carbon eutectic.

The Trend of Future Developments in Cast Iron.

Metallurgical workers in the field of cast iron have recognised for many years that the most important constituent in the structural composition is pearlite, and from the earliest days of the British iron industry castings have been made the structure of which was almost entirely composed of pearlite and graphite, with silicon, phosphorus, manganese, and sulphur in similar percentages to those now recognised as being

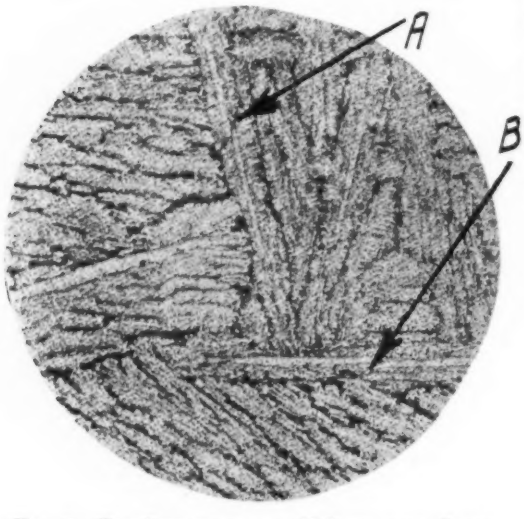


FIG. 5.—THE STRUCTURE OF A 95.7 PER CENT. IRON-EUTECTIC. A = FRACTURE OF CRYSTALS DURING CONTRACTION; B = WHITE CAST IRON.

sufficiently low for the best types of so-called pearlitic iron.

The development of research on this subject in Germany during recent years has been remarkable and of great importance to the cast-iron industry. The range of composition covering what may be termed pearlitic irons has been well illustrated by a diagram evolved by Dr. E. Maurer, of Essen, based upon earlier researches by Dr. Guillet on the properties of iron-silicon-carbon alloys. This diagram is shown in the lower part of Fig. 7, and consists of the four inclined lines passing through the point representing the 4.3 per cent. carbon 0.0 per cent. silicon alloy. Maurer has shown that the pearlitic irons lie within the lines 4.3 per cent. C, 7 per cent. Si, and 4.3 per cent. C, 2 per cent. Si.

In practice the sum of the carbon and silicon contents in pearlitic irons ranges between 4.0 per cent. and 5.2 per cent. The author has, therefore, drawn lines representing these two ranges through Maurer's diagram cutting the four Maurer lines, and enclosing an area shown by the hatched four-sided figure. This area represents very approximately the practical range of pearlitic irons.

Castings made from steel containing, say, 1 per cent. silicon, 1 per cent. manganese, and 0.2 per cent. phosphorus, and unannealed, would be unlike any cast iron composed of 2 per cent. graphitic carbon, 0.9 per cent. combined carbon, 1 per. cent. silicon, 1 per cent. manganese, and 0.2 per cent. phosphorus, although it has often been said that cast iron is simply a steel matrix with graphite as a weakening constituent.

It has been pointed out, however, that molten iron of, say, 3 per cent. carbon content is a mixture of the 4.3 per cent. carbon-iron eutectic and iron, which graphitises during cooling, producing, when cooled at a certain rate, silico-pearlite, graphite and free ferrite. The mechanism of this pearlite production is quite different from

FIG. 6.—SECTIONS OF CASTINGS MADE IN SLAG (CAST IN SAND MOULD) FROM PUDDLING FURNACE, SHOWING INFLUENCE OF THICKNESS OF CASTING ON CRYSTALLISATION AND GAS ESCAPE. ALL BARS WERE 6 INS. LONG.

that yielded by the ordinary steel-making processes, which function, in the absence of graphite, for in grey cast iron the pearlite formed is the product of the decomposition of austenite, resulting in a mixture of pearlite and graphite.

It has also been shown that when metal containing 3 per cent. carbon, 1 per cent. silicon, etc., is cast into a cold sand mould (or any other cold mould), the primary crystals at the mould surface are dendritic, enclosing probably and often a core of graphitic pearlite. This dendritic shell contracts at a different rate from the more highly graphitic central mass, and, though of greater

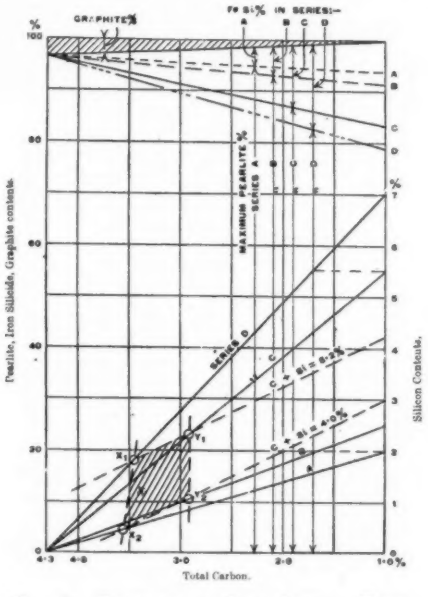


FIG. 7.—PEARLITE IN CAST IRON. FROM MAURER'S DIAGRAM (FE-SI-C), WITH EXTENSIONS.

tensile strength, is brittle, as most dendritic structures are.

If the 3 per cent. carbon, 1 per cent. silicon, iron is cast into a hot mould, the dendrites have time to grow, and, if the mould is heated to a temperature suitable to the thickness of the casting (higher for thin than for thick castings), and to the silicon and carbon contents, the dendritic structure can be made to disappear, and the entire mass becomes homogeneously pearlitic or very approximately so, in the various castings so far examined. This method of using sand moulds heated to determined temperatures is due to Diefenthaler and Lanz, and known as the Perlit process. The non-dendritic castings so made, though no higher in tensile strength than ordinary semi-steel castings of similar chemical analysis,

possess much higher resistance to repeated impact tests.

If similar cast iron, preferably rather higher in silicon and low in total carbon content, is melted and poured at a higher temperature into a cold or slightly warmed sand mould, the heat lost by the metal in cooling from its superheated temperature to the freezing point heats the mould, and a similar iron to that of Diefenthaler-Lanz is produced, but, judging from the higher tensile strength obtained, the dendritic structure is not entirely destroyed. The higher casting temperature must bring about a primary dendritic structure, which may be difficult to destroy, for, although the mould temperature, when freezing begins, may be as high as in the Lanz process, the viscosity of the metal may affect the breaking up of the dendritic structure in some cases.

The method of producing a high tensile pearlitic cast iron by means of warming the mould by superheated metal is due to Emmel, of Mulheim-Ruhr. At the moment comparative repeated-impact tests of the Lanz and Emmel irons are not in the author's hands, but such comparisons, when available, should be useful. The microstructure of the pearlite in the two irons is

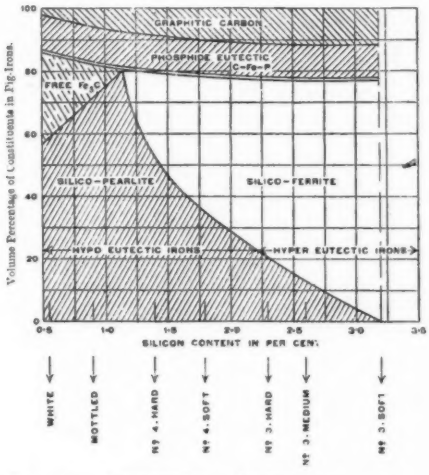


FIG. 8.—STRUCTURAL COMPOSITION OF A NUMBER OF PIG-IRONS PRODUCED IN THE SAME FURNACE. TC, 3.4 TO 3.6; CC, 2.8 TO 0.2; SI, 0.55 TO 3.25; MN, 0.70 TO 1.1; S, 0.30 TO 0.03; AND P, 0.7 TO 0.75.

similar, and not distinguishable from that in good ordinary pearlitic irons.

Another German development in the direction of high tensile cast irons is due to E. Schuz, and refers to the production of an iron containing about 3.5 per cent. silicon. This, when cast into metal chill moulds, has a dendritic structure—ferrite crystals being embedded in a eutectic of graphite and iron.

These three methods indicate the trend of foundry practice towards a more scientifically controlled chapter in the history of cast-iron founding. British blast-furnace owners are interesting themselves in the production of suitable pig-irons for the making of the better cast irons, which are evidently coming surely to the front, because of their value to the mechanical engineer. The structural composition of a series of pig-irons is shown in Fig. 8. These irons represent the general run of the numbers, from white to soft grey, as produced in the similar blast-furnaces of a company. When so depicted in graph form, the point at which pearlitic irons may be expected is clearly shown. The choice of suitable pig-irons for foundry mixtures is of great importance, and necessarily forms a subject of investigation by the Research Association.

No mention has been made of other moulding and casting methods, such as the use of permanent and semi-permanent and metal chill moulds, though in this connection the problems of structural composition, shrinkage and contraction are of paramount importance. Such methods are more connected with the mass production of castings, and, as many of these processes are being worked under patent licences individual attention to each typical process would take up more time than the author has at his disposal.

The author, in conclusion, is grateful to the Institution for the opportunity given to present the Paper, and hopes that the discussion of the points raised may be of service, especially to the designer of cast-metal structures. Also, to those members who may not have clearly understood the kind of work undertaken by the British Cast-Iron Research Association for its members in a serious attempt to improve the quality of cast iron, and of the products made in this still important metal.

Notes on Heating Ingot Iron.

Commercially pure iron (*i.e.*, Armco, which is 99.84 per cent. pure iron) is hot short at temperatures ranging from 850 to 1,050 deg. C., and if rivets are worked at these temperatures fractures will often result, so that in no circumstances should ingot iron rivets be heated above a cherry, *i.e.*, 800 deg. C. This means that it is necessary to avoid having any portion of the rivets heated to what is known as a "bright or full cherry." When uniformly heated to a dark or low cherry, such rivets will drive smoothly and easily, and the shrinkage pull will secure a tight seam. For the heating a mild air blast in the forge will heat the rivets uniformly without danger of high heating and with about one-fourth the fuel consumption of ordinary practice. Rivets up to ½ in. diameter should be cold riveted.

In welding with ingot iron it should be heated to a white heat or above, as in the case of a Norway or Swedish iron. The operator should not be afraid to get a high welding heat. The weld should be made as rapidly as possible, working until the temperature drops to bright orange, *i.e.*, 1,050 deg. C. If further dressing is necessary, the material should be allowed to cool to a cheery, 800 deg. C., when it can be worked until black without fear of fracture. If this ingot iron is hammered within the critical range, *i.e.*, between 850 and 1,050 deg. C., it will check or break.

In forging, the material should be heated to any temperature, from white heat (1,250 deg. C.) to welding heat (1,325 deg. C.). It should be forged as rapidly as possible, and worked down to bright orange (1,050 deg. C.). For light work, approximately 2 in. in thickness or diameter, forging should be stopped when the work reaches a temperature indicated by bright orange, and the work should be allowed to cool uniformly through the critical range to a cherry. When cooled to this temperature, forging may be continued, and the material worked until black without any fear of injury. No material is benefited by working at a blue heat, and it should be avoided.

Because of the hot shortness characteristic of pure iron, when forging or welding a heavy piece, it would be possible for the exterior to be below and the interior above the critical temperatures, and there would be an intermediate point between the two that would be extremely critical. For this reason it is advisable to re-heat heavy work. If the entire heated section is uniformly cooled through the critical zone it can be safely worked.

On work where one portion only is heated, heavy reduction as work approaches the cold end should be avoided owing to the possibility of getting into the critical range of temperatures, resulting in fractures.

Ingot iron should be bent at cold temperatures, at cherry or at bright orange. In flanging at high temperatures, care must be taken to heat enough surface to avoid approaching too near the cold part of the work. Cherry (800 deg. C.) is probably the safest and easiest point at which to work ingot iron, for at this temperature there is no danger of a critical condition. Working at blue heat is not advisable, and should be avoided.

Discussion on Mr. J. B. Hoblyn's Lecture on "Commercial Aluminium Alloys from the Users' Point of View."*

DR. R. S. HUTTON said he would like to quieten Mr. Hoblyn's anxiety caused by the work of Jasper and Moore in connection with fatigue range. He had noted that certain aspersions of this sort were being made about non-ferrous metals, and had been studying the subject thoroughly, because he was most anxious to see if anything could be done by encouraging further research to lay these aspersions by the heels. Quite recently work had been done in the American Navy Department by D. J. McAdam, Jun., which had discounted the work of Jasper and Moore, and had shown that the non-ferrous alloys, including duralumin, had quite definite fatigue limits. It was not only the aluminium alloys that had been threatened in this way. It had been quite generally assumed that we knew too little about most of the non-ferrous materials to render their use safe in extremely important applications where fatigue troubles might come in, and this recent work was to be welcomed. Its confirmation would assure non-ferrous materials being utilised in engineering construction on an even wider scale than at present.

MR. H. G. SOMMERFIELD (Hon. Secretary of the London Branch of the Institute of British Foundrymen) asked Mr. Hoblyn if there were any specific reason for employing nickel-chromium bolts in torque tube cases to the back axles to which he had referred.

MR. S. L. ARCHBUTT said he was glad that Dr. Hutton had remarked on the question of the fatigue range. The work of Jasper and Moore came rather as a bombshell at the time, but, as Dr. Hutton had indicated, care was needed in drawing conclusions. For purposes of design one needed to consider the life required from the various stressed parts made with these alloys. It might well be found that several generations of us would have passed away before a part received a sufficient number of alternations of stress to cause actual failure. In urging the importance of research work, having for its object the improvement of castings, he said in the past they had neglected castings, because they were weak, in favour of wrought material. One could not get good wrought material, however, unless one started with good castings. Therefore, anything the foundryman could do to improve his castings would be of the greatest value, and he hoped that some of the research work which had been done recently would help to improve the soundness of castings. He himself would go back to work with renewed energy still further to improve the properties of the castings, so that they could be relied upon to a greater extent than at present, and also to help the foundryman to overcome the difficulties he was encountering.

MR. CHARLES E. BARRS, who said he was chiefly interested in aluminium from the analytical point of view, said we had to bear in mind that aluminium was a comparatively recent metal; therefore, he endorsed Mr. Hoblyn's request to foundrymen to do their very best with it, because there appeared to be great possibilities for it in the future. Dealing with blow-holes in castings, he asked whether casting under pressure would help to eliminate the blow-holes.

Inherent Difficulties of Castings.

MR. WESLEY LAMBERT took up the cudgels on behalf of the foundrymen. He himself had had a fair amount of experience of aluminium alloy casting, particularly during the last few years, and had assiduously collected British, American and Continental literature on this subject, and he found the quantity of literature now available on aluminium and aluminium-alloy casting was almost overwhelming. That being so did not alter the fact, however, that notwithstanding all that had been written by both laboratory workers and practical foundrymen, blowholes were still to be found in a large number of the castings of to-day; moreover, no amount of heat treatment, short of remelting, would get rid of blowholes. A vast amount of laboratory work was carried out in connection with the light alloys, and the published results of tests occasionally indicated figures of a most promising character. Unfortunately, it would often appear that insufficiently comprehensive foundry trials had been made by the author of the paper, and one found that when venturing on the manufacture of commercial castings in any one such alloys, uniform results could not be ensured under the best foundry conditions. Even the problem of ensuring uniform tests from loose-cast test-bars is not easy of solution. In an American paper published some short while ago, illustrations were given of the various forms which test-bar castings may take, and comparative results were given of tests made on bars of the various shapes and methods of running therein described. The figures were very illuminating, as showing what variations in test results can be obtained from one and the same melt, even from castings of such simple shapes. This being so, one can more fully realise the difficulty the foundryman is up against in endeavouring to obtain uniform results when producing castings of a complicated character. In order to appreciate some of the difficulties in connection with the casting of aluminium alloys, one should essay to cast, under the best conditions at one's command, say, a dozen bars of 1-in. dia., and of a length of 12 in. The test results obtainable from such a set of cast bars may cause surprise. Some bars may afford excellent figures, others to appear to be rotten, and this to happen notwithstanding that so far as one can judge the conduct of the operation of founding, and the conditions prevailing, appear to be ideal. The foundryman is faced with many difficulties in the execution of his craft, and when it is remembered that the foundry foreman is largely dependent upon the human element, and that some foundry workers are less knowledgeable and less able to absorb what experience teaches than others, due allowance must be made for occasional casting failures.

On occasion when making a routine run covering a considerable number of castings of a large complicated pattern, it is not unusual to select a casting here and there, and to fracture it into many pieces in order to ascertain that the castings are coming out sound. Maybe, the casting is found to be a really good job, selected pieces, when tested, give results which are even better than the best results previously obtained from loose-cast test-bars. However, it may happen that a second casting may tell a different tale. How can the foundryman best secure soundness and uniformity of quality in light alloy castings? It is, indeed, a difficult problem, and aluminium is still in its infancy.

With steel castings, in the early days, serious troubles occurred of a like nature to those mentioned in the lecture. It was rarely that one obtained a homogeneous casting; blowholes and other defects of a more or less harmful character were nearly always present. Success can only come as a result of close application, keen observation, patient research, and an honest endeavour to produce the best castings possible. Happily, considerable success has been achieved in the production of sound aluminium alloy castings, and many thousands of tons of light-alloy castings have been made, and these have done, and are still doing, good service. Although here and there failures have occurred, it must be conceded that during the short time in which aluminium alloys have found a place in foundry practice the foundryman has done big things.

* This Paper was printed in our last issue.

MR. V. C. FAULKNER (Vice-President, Institute of British Foundrymen) said that Mr. Hoblyn's work stood out above that of all others, because he had always pleaded for co-operation between the various factors in engineering and metallurgy. With regard to the torque tube cases which had been mentioned, and to which bosses had been added, he asked Mr. Hoblyn to say whether or not the defect remained after the bosses had been added. On one occasion he himself had had the temerity to state that a perfect casting had not yet made its appearance, and that if one smashed up a casting into sufficiently small pieces one always found some defect. A friend of his, however, had said that he was wrong in that, and that he had forgotten about centrifugal casting. Therefore, it had occurred to him that the torque tube cases mentioned by Mr. Hoblyn might have been made as centrifugal castings, and he might then have received what he had asked for.

MR. A. G. COLLINS asked if Mr. Hoblyn could give information with regard to the use of light aluminium alloys for motor car wheels, such as had been raced successfully by Bugatti's abroad, and such as had been experimented with, he believed, by certain omnibus companies.

Practical Application of Research Work Ineffective.

MR. G. C. PIERCE (President) said he had found nothing in the lecture which would help the foundryman to avoid blowholes and other defects. He had been dealing with aluminium on and off for the last 18 years, and he had carefully read all the literature he could get on the subject, but, except for one or two practical papers—and it was pretty obvious to him that the people who contributed practical papers made castings containing blowholes and other defects—he had not found any constructive work as to the amelioration of defects. One gentleman had propounded a theory that some aluminium alloys, if melted in the pot and allowed to solidify, and then put back in the fire, might be produced without blowholes. He himself had tried it for three months, but it had not done away with defects, and three months' conscientious trial was pretty good in a foundry which had to turn out castings at competitive rates. With regard to co-operation between foundrymen and designers, he said he had tried to co-operate with designers, and the rebuffs he had experienced were sufficient to break the heart of any foundryman. A founder would perhaps make twenty or thirty castings of a particular kind and find himself face to face with difficulties every time, but if he saw a possible way out of those difficulties and suggested it to the designer, the latter would not accept it. That was not merely his experience with one particular designer, but several, and he could only hope that all the designers with whom he came into contact would bear in mind what Mr. Hoblyn had said in this connection. One of the bugbears in the foundry world was that prices were cut to such an extent that there was very little scope for a foundryman even to study his job as he ought to do.

MR. A. H. MUNDEY agreed that the question of blowholes was ever with us, and he did not think anybody was yet prepared to say how they were to be got rid of. We all had certain notions, and perhaps nostrums, but we could not avoid blowholes. He had not yet seen a casting of any complexity which, when cut up, was found to be completely free from them, although, of course, pieces could be taken from one part or another in which they were not present. He agreed with Mr. Hoblyn that good results were often obtained experimentally, but when the castings were made under quantity-production conditions, the results were not so good. The everlasting bugbear was the necessity for producing the castings at competitive prices, and when producing in quantities we would surely get a percentage of failures because we were tied down to price.

Cracks in Torque Tube Casings.

Referring to the torque tube casings in which incipient cracks were manifest, he said he had a notion that those cracks, which could not be seen by visual examination in the view-room, had already started before the castings were taken out of the sand. There was a period when the material had no strength at all, so to speak, and microscopic strains became evident. One knew, of course, that there were stresses due to contraction in cooling, but the material was actually strained, and it was only a matter of luck in many cases that those strains did not develop and cause breakdown of the castings. That led us to the question of co-operation between the designer and the metallurgist. Though Mr. Pierce had spoken rather severely of the designer, he himself had had the luck to co-operate with a designer who had a considerable knowledge of metallurgy and a great knowledge of production, and he must confess that he owed an enormous debt to that man. They were producing aluminium and other castings which were very subject to these troubles, and he felt certain that it was the designer's knowledge of metallurgy and his sympathy and appreciation of the difficulties which had helped them to avoid a great deal of trouble. Dealing with Mr. Hoblyn's challenge as to the use of aluminium alloys as bearing metals, he said that had not frightened him. He did not want to see the ordinary white metals wiped out yet, but if they were, we should go on making "Y" alloy.

Rendering Blowholes Harmless.

MR. S. G. WILLIAMS said he had lived in somewhat close touch with the difficulties of the foundryman, and there was one thing for which he had not been given credit that evening, namely, his ingenuity in placing the blowholes in those parts of castings which mattered the least. Discussing Mr. Hoblyn's statement that L5 alloy gave an elongation of 4 or 5 per cent., he assured him that that figure was not obtained from a casting. The figures one could expect from a test piece cut from an ordinary casting would be 7 or 8 tons per sq. in. maximum tensile, with approximately 1 per cent. elongation. They were not specification figures. A chill cast test bar would give about 14 tons per sq. in. maximum tensile, and 4 to 6 per cent. elongation, as required by specification. With regard to the modified aluminium-silicon alloy mentioned, and the fact that the modified metal had reverted at the thick end of the casting, this would happen under conditions of slow cooling, but if a chill was used better results would be obtained. Further, if one could afford a die-cast job, one approached nearer to the ideal casting. It was a question of quantity. The ideal would usually be a die, failing that on grounds of cost recourse should be made to heavy chills. If there were only a small number of castings to be made, however, one had to use sand, with all its troubles. He did not agree altogether with Mr. Hoblyn's remarks as to the American automobile practice versus English. We could learn quite a lot from American methods of production, and he believed it was on quantity production lines that many of our troubles would be solved, because it would be possible to give the founder a good order for many thousands of parts, so that he could lay out his plant for it and turn out a better job. The orders were placed by purchase departments, who could remove many of the troubles of the foundry by sympathetic treatment. Luxury cars had their place, but they would not build up national trade, and it might be better, therefore, to concentrate on a national article rather than on a small number of luxury cars. The "Y" alloy, as cast, had considerable possibilities, especially when it was heat-treated, but much pioneer work remained to be done before we had foundries conducting heat-treatment with an assurance equal to that of the steel forges. With regard to the fatigue range of duralumin, he said that the material was not a truly homogeneous one, and he believed that the discontinuities usually present had some bearing on the variable fatigue results mentioned by the previous speakers.

THE AUTHOR'S REPLY.

MR. HOBLYN, in his reply, said he wanted it to be realised that the Vauxhall Company had used light aluminium castings in stressed parts. He asked how many others had had sufficient

faith in the British foundryman to use his castings and try them out so thoroughly. Actions spoke louder than words, and the Vauxhall Company had been prompted to use aluminium castings by their faith in the British foundryman, who was not afraid to be told when he made errors. The breakdown of a car was far more serious than the breakdown of a casting. The work of Jasper and Moore on the fatigue range of duralumin had disturbed him for a few weeks, but, as had been pointed out, it could be regarded a little less seriously than he had regarded it. He had gone so far as to work out from data based on these tests, how long duralumin connecting rods would last, and had found that a car with those rods fitted would, even at the worst, probably run about 180,000 miles.

With regard to the nickel-chrome steel bolts used on the torque tube casing, he said they were fitted because of their great strength.

Dealing with Dr. Barr's reference to pressure die casting as a means of getting rid of blowholes, he said that he personally did not like pressure die casting for stressed parts. During the process the metal was forced up into the die, but it was possible for air to enter and cause pin-pricks, which made the castings weaker than they would be otherwise.

MR. HOBLYN assured Mr. Lambert that he fully appreciated the founder's difficulties, and the fact that he was doing his best to overcome them.

With regard to the addition of the bosses to the torque tube casing, he said that he had asked for them to be added just at the time when the salespeople were saying that they dare not have any more breakages, and the Company went back to steel. He firmly believed that those bosses would have materially strengthened the casting.

The Company had pistons, as well as a back axle casing, of magnesium alloy in use, and giving satisfactory results. He would not like to pronounce on it as a productive proposition, however. He did not feel that an alloy with a Brinell number of 67 would behave as well in the engines as one with a Brinell number of over 100, and he was going to use what was claimed to be a pure magnesium, patented by Michell, who claimed to have got rid of all the oxide, and that the product was 99.9 per cent. magnesium.

He had seen many wheels cast in ordinary L5. which had been tested under severe conditions by a certain motor omnibus company, and had stood very well, so that he believed the possibilities of the aluminium cast wheel were very important, and were well worthy of attention.

Dealing with Mr. Pierce's query as to how to get rid of blowholes, he said that that was not his job. Mr. Williams, however, had said that the foundryman could put the blowholes in any part of a casting, so that perhaps he could suggest how the foundryman could put the blowholes outside a casting altogether. (Laughter.) The price consideration, he agreed, was important, and the Vauxhall Company had paid very heavy prices for some of their castings in the past, simply because they wanted the very best materials. The material, on analysis, had always been sound and well up to specification, and the Company would not like to feel that they were paying a lower price and getting a larger percentage of scrap.

If Mr. Mundey could set up a crusade to teach designers metallurgy, it would be an excellent thing. All along he had urged co-operation between the designer and the founder, because he was the one who had felt the lack of it, and he would go on preaching, because this co-operation was essential at the present time.

Standardisation.

Mr. Williams had taken him to task for having mentioned a figure of 4 or 5 per cent. elongation for L5 test pieces. At every Standards Association meeting this question cropped up, as to how one could get a specification which did reflect the properties of a casting 2 in. or 3 in. thick in some places and 6 in. thick in others. One got to know the quality of the material, and that was all one could get. It was an open question as to whether British or American methods were best for this country. But while progress was essential the value of tradition must not be overlooked. A standard was a very good thing, because one could lock it up in a cupboard and keep it for reference, but we often talk foolishly of standardisation. Was individuality to go? There was a danger of too much standardisation, and he urged that British products should be characterised by individuality.

Vote of Thanks.

MR. G. C. PIERCE, proposing a vote of thanks to Mr. Hoblyn for his lecture, referred further to the difficulties encountered by the foundryman. In one instance he had been asked to make castings out of a patented aluminium alloy, previously made of gunmetal. He had found difficulties with the new aluminium, however, and, after several attempts to make the castings, he had suggested that the patterns should be sent to the metal manufacturers, and that they should be asked to make the castings. Accordingly, they were sent. When, subsequently, he had suggested that it was time some results were forthcoming inquiries showed that the firm in question had made seven attempts but had not yet succeeded in making castings. That was the type of material that was dumped on the market from which foundrymen were expected to make castings. With regard to heat treatment of aluminium, he said that he had made a casting in Y alloy, and had told the blacksmith that he wanted it put through a course of heat treatment at a certain temperature, but when he went to see his casting he had found a blob of metal.

The vote of thanks was seconded by MR. LEWIS (of the Research Department at Woolwich Arsenal) and accorded with enthusiasm.

The meeting then closed.

New Refractory Cement and Gun to Apply it.

A "carboplastic" cement and a "carboplastic" gun used for applying the cement are new products in the field of refractories which have been introduced by the Carborundum Co., Niagara Falls, N.Y.

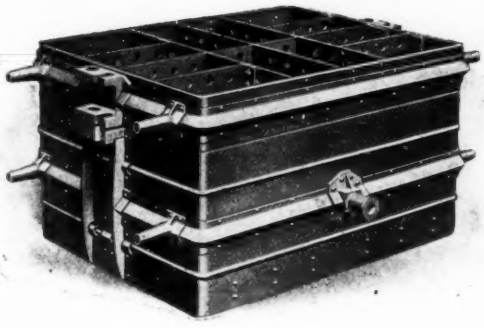
The principal ingredient of the cement is carborundum, a highly refractory material. Because of the proper selection of bonding materials, carboplastic cement is said to retain the refractory properties of carborundum and at the same time lend itself readily to application with the carboplastic gun. The cement is prepared for use simply by the addition of water to give it the proper consistency. It air sets with a strong bond and is said to be more resistant to high temperatures than the best grades of fire brick.

The principal uses for carboplastic cement are in minimising the serious effects on fire brick settings of localised flame impingement, of cavities due to spalling and cracking, of clinker formation and other causes for maintenance and repair expense. By applying carboplastic cement as a coating over a fire brick face or as a plastic refractory for patching, the life of fire brick settings is materially increased, it is asserted, and the need for frequent shutdowns for repairs is eliminated. The cement can be applied to either hot or cold settings.

The carboplastic gun for applying the cement is truly portable, weighing but 12 lb. It has no moving parts to get out of order and cause trouble, and is operated by a single valve located close to the handle. The gun is operated by either steam or air at 100 lb. pressure. It is small, compact, easy to handle and can discharge 50 lb. of carboplastic cement in less than half a minute. It sucks the cement from an ordinary pail or bucket. There is no auxiliary hopper. Complete information regarding the cement and the gun is available from the Carborundum Company, Refractory Division, Perth Amboy, N.J.—*Iron Age.*

Sterling

ROLLED STEEL



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SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

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J. GRAYSON LOWOOD & Co., Ltd.

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Telegrams: "LOWOOD, DEEPCAR."

Trade Talk.

ALEXANDER & COMPANY, LIMITED, have removed to 80, Fenchurch Street, London, E.C.3.

LUNT BROS., 75-77, Colmore Row, Birmingham, have removed to 13, Colmore Row, Birmingham.

WILLIAMS & WILLIAMS, LIMITED, of the Reliance Works, Chester, have despatched to the Argentine a train-load of metal windows, representing the first 90 tons out of a total 250 tons, which is a record consignment.

LADY MARGARET LINDSAY, daughter of the Earl of Crawford, chairman of the Wigan Coal & Iron Company, Limited, has restarted the No. 2 blast furnace at the company's Kirkless Works, Wigan. An additional battery of 54 coke ovens has also been restarted.

THE COPPER SHEET section of the business of Nevill, Druce & Company, Limited, has been amalgamated with that of John Bibby, Sons & Company (Garston), Limited, and shortly all such sheets will be rolled at Garston. The wire-drawing plant at Llanelly will be continued.

JOS. BOOTH & BROS., LIMITED, Rodley, Leeds, are supplying 22 electric locomotives for the constructional work of the Ben Nevis tunnel in connection with the new power station of the British Aluminium Company, Limited. These locos. are to be equipped with "Exide" batteries.

JOHN BEDFORD & SONS, Lion Works, Sheffield, have purchased the file manufacturing business of James Leigh & Sons, Limited, Progress Works, Sudbury Street, Sheffield. In future the latter business will be conducted from the Lion Works. Mr. P. Leigh has been appointed to represent the company in Manchester.

FOUR HUNDRED NEW LOCOMOTIVES and 15,000 goods wagons are included in the scheme of renewals and improvements which has been authorised by the board of the London, Midland and Scottish Railway for 1926. Further orders, notably for passenger train stock, are in contemplation, the total cost approximating £10,000,000. Locomotive and wagon construction will be carried out partly in the company's own workshops, but the greater part of it will be undertaken by private firms.

THE DUKE OF YORK will go to Birmingham during the first week of the British Industries Fair, to be held at Castle Bromwich from February 15 to 26. His Royal Highness will be entertained to luncheon, and will afterwards make a tour of the Fair. The entries this year are exceptionally numerous. The most important sections will be ironmongery and general hardware and engineering, and the electrical exhibits will show a substantial improvement on the display of last year.

THE GEAR GRINDING COMPANY, LIMITED, Handsworth, Birmingham, have completed arrangements by which a gear-grinding company has been established in Milan, Italy. This company will be known as the Società Italiana Rettifica Ingranaggi (S.I.R.I.). The works will be equipped with the Gear Grinding Company's special tooth-grinding machines, and the plant will be operated on similar lines to those employed in the Birmingham shops. The new Italian company has purchased the sole rights for the use of the Gear Grinding Company's patents and process in Italy.

THE LEEDS FORGE COMPANY, LIMITED, Leeds, have received an order from the High Commissioner for South Africa for five hundred all-steel bogie covered wagons, each of forty tons capacity. These wagons are for the conveyance of grain in bulk from the farming districts to South African ports, and are specially designed to suit the elevator system recently installed at the main up-country stations and at the ports of Capetown and Durban. In addition to the foregoing the company have also received from the High Commissioner an order for seventy all-steel bogie hopper coal wagons of the same type as previously supplied.

LEOPOLD FARMER & SONS, 46, Gresham Street, London, E.C.2, in their report last year write that in reviewing the year's operations in connection with the dealing in factories, wharves, warehouses, land, etc., the business carried through has been extremely good and in excess of the previous year. There has been a constant demand for this class of commercial property, which in the latter months has considerably grown, no doubt due, in many cases, to the progress of the Safeguarding of Industries Bill, which has proved a great incentive for the acquiring of factories all over the country by British as well as foreign firms. The increased activity in trade generally is also another important factor for the enlargement of works and the establishment of new ones, while the prices obtained have been satisfactory and progressive. Another feature in connection with the commercial world has been the increasing tendency to have the assets of limited liability companies valued. At the present moment there are as many inquiries for factories, if not more so, than there have been for some years.

Personal.

MR. E. C. GODDARD has been elected a director of Henry Bath & Son, Limited, 53, New Broad Street, London, E.C.2.

MR. H. J. MILLS has resigned his position with Mosenthal, Sons & Company, 72, Basinghall Street, London, E.C.2, in consequence of ill-health.

MR. C. BENTHAM, of Henry Simon, Limited, has been elected a member of the executive of the Manchester District Engineering Trades Employers' Association.

MR. F. R. E. DAVIS, the assistant secretary to the Great Western Railway Company, has succeeded Mr. A. E. Bolter as secretary, upon the latter's retirement after 55 years' service.

MR. CHARLES MARKHAM, chairman of the directors of the Staveley Coal & Iron Company, Limited, has been the recipient of presentations from the workmen employed in the company's pits, to mark the occasion of his recent marriage.

MR. WHITE, manager of Messrs. Ambrose Shardlow, of Washford Road Works, Sheffield, has been the recipient of a presentation from the staff and workmen of the firm, on his leaving to take up an appointment as works superintendent at the Lincoln wagon works of Messrs. Clayton.

MR. H. A. COUVES has been appointed general manager of the Newcastle-upon-Tyne Electric Supply Company, Limited, Royal Exchange Buildings, Newcastle-upon-Tyne, and the following associated companies, viz.: Cleveland and Durham County Electric Power Company, Cleveland and Durham Electric Power, County of Durham Electric Power Supply Company, County of Durham Electrical Power Distribution Company, Houghton-le-Spring and District Electric Lighting Company, and the Northern Counties Electricity Supply Company. Mr. Couves, who joined the Newcastle Company some twenty years ago, has occupied the position of chief of the power and construction departments during the greater portion of that period.

Wills.

PRESTON, J., Birkdale, Lancs., engineer	£22,569
MASON, A., Leicester, engineer and iron-founder	£5,749
MALLINSON, R., of Moorcroft, Skircoat Moor Road, Halifax, founder and formerly chairman and director of R. Mallinson & Company, Limited, wire goods manufacturers, Greenmount Works	£3,413

Obituary.

MR. WILLIAM DOWNING, assistant general manager of the Sheffield Refractories Company, Limited, died recently. Mr. Downing was a former assistant secretary of the Sheffield Compo and Ganister Association, and the Refractories Association.

MR. T. SWIFT LEVICK died on January 1, at his residence, Kirkleigh, 6, Endcliffe Grove Avenue, Sheffield. Mr. Levick, who was 80 years of age, had been closely connected with the steel trade since he was 17 years of age, and devotion to business resulted in his building up the well-known firm of Swift Levick & Sons, Limited, of Clarence Steel Works, Leveson Street, Sheffield. A native of Sheffield, Mr. Levick was educated at Wesley College, and as a youth he entered the firm of Charles Cammell & Company (now Cammell, Laird & Company), under Mr. George Wilson, who was then managing director. From a position in the office he rose to manager of the spring department. From Cammell's Mr. Levick went to Seebohm & Dieckstahl (now Arthur Balfour & Company), when both Mr. Seebohm and Mr. Dieckstahl were in active partnership, and he travelled for the firm in England. In 1883 Mr. Levick decided to commence business, and the firm of Levick, MacGillivary & Company came into being in Arundel Street, as manufacturers of steel and files. In 1891, the partnership was dissolved, and the firm of Swift Levick & Sons was commenced in the present premises in Leveson Street. The business steadily grew, and in 1900 the business became a private limited company, with Mr. Swift Levick as chairman of the board.

THE SECRETARY of Cole Marchant & Morley, Limited, engineers, of Bradford, has sent out a circular letter to the firm's creditors in which he states that circumstances have arisen which have compelled the debenture holders to enforce their security and appoint receivers. They have appointed Mr. Alfred Greaves, chartered accountant, and Mr. R. S. Brailsford as joint receivers, and they intend to carry on the business.

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OEHM'S

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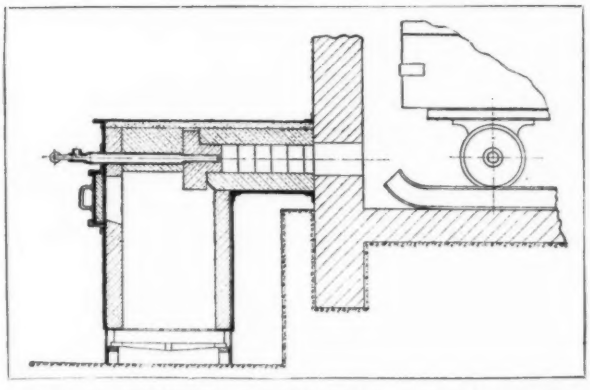
HEATING ELEMENTS

(ENTIRELY BRITISH MADE.)



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(other models are designed with *Vertical* Heat - Outlet).

Other features are:—

Simplicity of Design

There are no moving parts, nothing to give trouble.

Economy in Fuel

The cheapest kind of fuel can be used, and only half the usual quantity required.

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Heating and drying work effected in half the time taken by other methods, and in mould drying ensures a BETTER CASTING.

The OEHM'S Patent Heating Element is the simplest and the most efficient apparatus yet devised for producing high temperatures by the conversion of solid fuel to CO_2 gas, possessing pressure and velocity without flame and without smoke.

For Core and Mould drying on the floor, in Pit or Drying Rooms. For Heating Ladles, Shanks, Ingots, etc. For Annealing and all Heat Treatments.

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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—The position in the Cleveland iron market may now be accurately described as distinctly more promising than has been observable for many months, the tone all round being very strong and confident. It is, moreover, satisfactory to note that the recent advance in prices has not checked the home demand, which is still quite active. Scotch inquiry has perhaps been somewhat quieter, but this may well be due to holiday interruptions. Consumers probably fear further advances, and in view of the pronounced scarcity are endeavouring to cover their needs forwards as far as conditions will permit. Export business is quiet, but it is rather too early yet to gauge the effects of the higher Cleveland prices on trade with the Continent. On the whole, however, exporters take a hopeful view, as costs and prices abroad must inevitably continue their upward trend. The improvement in the franc is a favourable point. Minimum quotations for home are as follow, export prices being 6d. per ton more :— No. 1, 71s. 6d.; No. 3, 69s.; No. 4 foundry, 68s.; and No. 4 forge, 67s. per ton.

The hematite market on Tees-side continues, if anything, more active than was previously reported, and, if demand shows much more expansion, famine conditions may easily prevail. Coincidently with the improvement in the home demand, there is a distinctly better inquiry from the Continent, notwithstanding the higher price of the Cleveland material. This week 77s. per ton is strictly a minimum figure for East Coast mixed numbers, and the steady upward movement looks like continuing. The No. 1 quality remains at a premium of 6d. per ton. On the North-West Coast demand has practically overtaken consumption, with Bessemer mixed numbers quoted at £4 1s. 6d. c.i.f. Welsh ports, £4 7s. 6d. per ton delivered at Glasgow, £4 10s. 6d. per ton delivered at Sheffield, and £4 13s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—A rather more hopeful view of the outlook for foundry pig in this district is now freely expressed, and both demand and inquiry are in much better volume than recently reported. So far prices at Manchester have been little affected by the advance in Cleveland iron, but it is considered probable that the Midland makers may make an early move in that direction, and sellers are already talking of 74s. 6d. to 75s. per ton, delivered Manchester, although consumers have not yet paid so much. Many local consumers will probably wait until after the Birmingham quarterly meeting before placing any reliance on the claim of sellers to advance the prices for foundry iron.

THE MIDLANDS.—The most important trade event of the current week has been unquestionably the quarterly meeting at Birmingham, which was more largely attended than usually by members from all parts of the Kingdom. Business was on an active scale, many consumers having postponed orders until this occasion, with a view of more accurately gauging market feeling on the subject of prices. It is considered likely that there will be much heavy tonnage booked for a little time, in view of the fact that many consumers have already covered for the first quarter of the year, in any case, up to the end of February. Current quotations are as follow:—Derbyshire No. 3 foundry, 66s. 6d. to 67s. 6d.; forge, 59s. to 60s.; Staffordshire No. 3 foundry, 67s.; forge, 60s.; Northants No. 3 foundry, 62s. 6d. to 63s. 6d.; forge, 54s. 6d. to 55s. 6d.

SCOTLAND.—Resumption of work after the holidays has been slow, and consequently market business is quiet. Scotch iron remains easy on the basis of 76s. 6d. for No. 3 foundry at the furnaces, but Middlesbrough iron, on the other hand, is reported to be very firm at 73s. 6d. f.o.t. Grangemouth for No. 3 foundry, and in cases where some of the makers are very well sold they are asking 6d. per ton more.

Finished Iron.

Improvements, as concerns most of the manufacturing departments, is a very slow process, though it is reported at Birmingham that there is a little more business doing in crown iron at the same prices which have been ruling for the last three or four weeks, namely, £11 7s. 6d. to £11 10s., according to specification. The makers of fencing and nut and bolt iron have been poorly situated for some few weeks, but the trouble in Belgium will certainly have the effect of delaying deliveries, and this might help the local makers of this class of iron. The present quotation is in the region of £10 7s. 6d. per ton. Belgian quotations for this class of iron vary from £6 17s. 6d. to £7 5s. per ton. With regard to marked bars, which are still quoted at £14 at makers' works, there has not been much business available of late, but the makers are hopeful that a better state of affairs will shortly be established as trade gradually improves in the engineering branches.

Steel.

At Sheffield business in the various departments of the steel industry has continued quiet all round, and prices of billets of all descriptions are unchanged. Sellers, however, are convinced that the prices now ruling are the lowest that will be quoted. There is less imported material available, but users still have fair stocks of these cheap billets in hand. Practically the same amount of steel-producing plant is now running as before the holiday, which means that a considerable number of furnaces continue out of operation. Most of the strip and bar and wire rod mills are on short time.

Scrap.

The increased activity in the pig-iron demand has been followed by a corresponding improvement in the markets for scrap, which in Lancashire have been rather depressed for some time, less than 70s. having been accepted for good ordinary cast metal, but last week the dealers were stiffer, and although no test of selling prices will be possible for a few days, yet the tendency was to quote up to 72s. 6d. per ton for broken machinery metal, and up to 75s. for "textile" scrap. That the demand for the latter will improve is assumed by the fact that more inquiry has been about for Scotch pig-iron. This is an indication that textile machinery makers are buying material for their castings, and textile scrap at 75s. is a cheap foundry material for them, seeing that they will have to pay about 20s. more for Scotch No. 3 pig-iron.

Metals.

Copper.—The position of standard copper has experienced a further setback in values, although within quite narrow limits, quotations not yet having receded below the £59 level. There has been little or no interest on the part of consumers over the year end due to stocktaking, and presumably the fact that market prospects are still viewed in a conservative and even indifferent light. Yet the consumption in the United States has been at a decidedly progressive rate, and also very much better in this country judging from the large quantities imported. Current quotations : — *Cash* : Thursday, £59 5s.; Friday, £59 7s. 6d.; Monday, £59 10s.; Tuesday, £59 15s.; Wednesday, £59 10s.

Three Months : Thursday, £60 5s.; Friday, £60 10s.; Monday, £60 10s.; Tuesday, £60 15s.; Wednesday, £60 12s. 6d.

Tin.—Notwithstanding the fact that last week's closing prices marked a decline from the best, the market for tin continues firm on moderate dealings. The statistical position may be regarded as satisfactory. According to the returns issued by the London Metal Exchange, the visible supplies of tin are again down, the deliveries being 175 tons higher than in November. This will have a tendency to keep the value of the metal on a high plane. Whereas a year ago the home stocks were more than double their present quantity, and cash tin was then at a discount of over £3, the position of the latter is precisely he reverse, as shown by the abnormally heavy premium ruling. Current quotations : — *Cash* : Thursday, £285 5s.; Friday, £285 5s.; Monday, £283 5s.; Tuesday, £285 10s.; Wednesday, £287.

Three Months : Thursday, £278 5s.; Friday, £278 5s.; Monday, £277 5s.; Tuesday, £278 5s.; Wednesday, £278 17s. 6d.

Spelter.—Consumptive demand for this metal is still on a moderate scale, while latterly there has been increased selling. The particular firmness at one time was of a very technical character, and seems in all probability to have been due to delayed shipments of Continental metal, on account of the recent severe weather ruling on the Continent, and consequent delay in transport. Current quotations :—*Ordinary* : Thursday, £38 16s. 3d.; Friday, £39 3s. 9d.; Monday, £38 18s. 9d.; Tuesday, £38 13s. 9d.; Wednesday, £38 15s.

Lead.—The market for soft foreign pig has been fairly active on the whole, firmer, and, though reacting a little, has since recovered. The firmness was largely due to some fairly general buying of a somewhat speculative character, attracted no doubt by the comparatively low price and by the assumption that trade demand will improve and consumers will have to buy on a more liberal scale with the New Year. Arrivals, however, are still heavy. Current quotations :—*Soft foreign (prompt)* : Thursday, £34 17s. 6d.; Friday, £34 17s. 6d.; Monday, £35; Tuesday, £35 7s. 6d.; Wednesday, £35 6s. 3d.

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ROBSON REFRACTORIES LTD.

1, North Road,

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CUPOLINE STORAGE DEPOTS AT:

Middlesbrough, Leith, Newcastle-on-Tyne, Newport (Mon.), Garston, Liverpool.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash ..	59 10 0
Three months ..	60 12 6
Electrolytic	66 0 0
Tough	63 0 0
Best selected ..	64 0 0
Sheets	90 0 0
India	75 0 0
Wire bars	66 10 0
Do. Jan.	66 0 0
Do. Feb.	66 0 0
Ingot bars	66 0 0
H.C. wire rods ..	70 5 0
Off. av. cash, Dec. 59	12 0 5/11
Do., 3 mths. Dec. 60	12 10 1/11
Do., Sttlmnt, Dec. 59	11 9 9/11
Do., Electro, Dec. 65	16 8 3/11
Do., B.S., Dec. .. 64	7 0
Aver. spot price copper, Dec. .. 59	11 10
Do., wire bars, Dec. 66	0 11
Solid drawn tubes	13d.
Brazed tubes ..	13d.
Wire	10d.

BRASS.

Solid drawn tubes ..	12d.
Brazed tubes	13½d.
Rods, drawn	11½d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g ..	10½d.
Wire	10½d.
Rolled metal	9½d.
Yellow metal rods ..	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

	£ s. d.
Standard cash ..	287 0 0
Three months ..	278 17 6
English	285 10 0
Bars	286 5 0
Straits	286 15 0
Australian	286 5 0
Eastern	283 0 0
Banca	290 10 0
Off. aver. cash, Dec.	285 1 0 2/11
Do., 3 mths., Dec.	279 3 8 7/11
Do., Sttlmt. Dec.	285 0 5 7/11
Aver. spot., Dec.	285 0 5½

SPELTER.

	£ s. d.
Ordinary	38 15 0
Remelted	37 5 0
Hard	32 5 0
Electro 99.9 ..	42 10 0
English	39 15 0
India	33 5 0
Zinc dust	46 0 0
Zinc ashes	15 10 0
Off. aver., Dec.	37 17 9 3/11
Aver., spot, Dec.	38 6 6½

LEAD.

	£ s. d.
Soft foreign ppt.	35 6 3
English	36 10 0
Off. average, Dec.	34 11 10 3/11
Average spot, Dec.	34 14 9½

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	46 0 0
Do. V.M. ex whf.	44 10 0
Rods	51 0 0
Boiler plates ..	44 0 0
Battery plates ..	44 0 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	105 0 0
Chinese	100 0 0
Crude	70 0 0

QUICKSILVER.

	£ s. d.
Quicksilver ..	15 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon	
25%	9 10 0
45/50%	11 15 0
75%	21 10 0
Ferro-vanadium—	
35/40%	15/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	6/1 lb.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%,	£20 0 0
Ferro-tungsten—	
80/85%, c.fr. 1/9 lb. to	1/9½
Tungsten metal powder—	
98/99%	2/– to 2/1 lb.
Ferro-chrome—	
2/4% car. ..	£34 5 0
4/6% car. ..	£23 5 0
6/8% car. ..	£22 17 6
8/10% car. ..	£22 7 6
Ferro-chrome—	
Max. 2% car.	£40 10 0
Max. 1% car.	£48 0 0
Max. 0.70% car.	£56 10 0
70%, carbonless	1/5 lb.
Nickel—99%, cubes or pellets	£172 to £177
Cobalt metal—98/99%	10/– lb.
Aluminium 98/99%	£123
Metallic Chromium—	
96/98% ..	3/6 lb.
Ferro-manganese (net)—	
76/80%, loose	£15 7 6
76/80%, packed	£16 7 6
76/80%, export	£15 5 0
Metallic manganese—	
94/96%, carbonless	2/– lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s. d.
Finished bars, 14% tungsten ..	2 6
Finished bars, 18% tungsten ..	3 0

Per lb. net, d/d buyers' works.

Extras—
- Rounds and squares 3 in. and over .. 4d. lb.
- Rounds and squares under ½ in. to ¼ in. 3d. lb.
- Do. under ¼ in. to ⅛ in. .. .. 1/– lb.
- Flats, ¼ in. × ⅛ in. to under 1 in. × ⅜ in. 3d. lb.
- Do. under ¼ in. × ⅛ in. 1/– lb
- Bevels of approved sizes and sections 6d. lb.
- Bars cut to length 10% extra

Scrap from high-speed tool steel—
- Scrap pieces .. .. 3d.
- Turnings and swarf 1d.

Per lb. net, d/s steel makers' work

SCRAP.

South Wales—	£ s. d.	£ s. d.
Hvy. steel	3 7 6	3 10 0
Bundled steel & shrngs.	3 2 6	to 3 6 0
Mixed iron & steel	3 2 6	to 3 3 6
Heavy cast iron	3 2 6	to 3 5 0

	£ s. d.
Good machinery for foundries	3 7 6 to 3 10 0
Cleveland—	
Heavy steel ..	3 5 0
Steel turnings ..	2 5 0
Cast iron borings	2 5 0
Heavy forge ..	4 2 6
Bushelled scrap	3 7 6
Cast-iron scrap	3 2 6
Lancashire—	
Cast-iron scrap	3 12 6
Heavy wrought	3 7 6
Steel turnings ..	2 0 0

London — Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean) ..	52 0 0
Brass (clean) ..	40 0 0
Lead (less usual draft)	31 0 0
Tea lead ..	27 0 0
Zinc	26 0 0
New aluminium cuttings ..	92 0 0
Braziery copper	45 0 0
Gunmetal ..	46 0 0
Hollow pewter	195 0 0
Shaped black pewter ..	145 0 0

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1 ..	71/6
Foundry No. 3 ..	69/–
Foundry No. 4 ..	68/–
Forge No. 4	67/–
Hematite No. 1 ..	77/6
Hematite M/Nos. ..	77/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	87/6
,, d/d Birm.	93/6
Midlands—	
Staffs common* ..	—
,, No 4 forge ..	60/–
,, No. 3 foundry	67/–
Shrops. basic	70/–
,, Cold blast, ord.*	185/–
,, ,, roll iron* ..	190/–
* d/d Birmingham.	
Northants forge	55/–
,, fdry No. 3 ..	63/–
Derbyshire forge ..	59/6
,, fdry. No. 3 ..	67/–
,, basic	65/–
Scotland—	
Foundry No. 1 ..	81/6
,, No. 3 ..	76/6
Hem. M/Nos.	76/6
Sheffield (d/d district)—	
Derby forge	63/6
,, fdry. No. 3 ..	70/6
Lincs. forge	68/–
,, fdry. No. 3 ..	70/–
E.C. hematite	87/6
W.C. hematite ..	90/–
Lincs. (at furnaces)—	
Forge No. 4	60/–
Foundry No. 3	62/–
Basic	62/–
Lancashire (d/d eq. Man.)—	
Derby forge	67/–
,, fdry. No. 2 ..	74/6
Northants foundry No. 3	75/9
Dalzell, No. 3	110/–
Summerlee, No. 3 ..	94/–
Glengarnock, No. 3 ..	94/–
Gartsherrie, No. 3 ..	94/–
Monkland No. 3	94/–
Coltness, No. 3	94/–
Shotts, No. 3	94/–

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	11 5 0	to 12 10 0
Angles	11 10 0	
Tees to 3 united ins.	12 0 0	
Nut and bolt ..	10 15 0	
Hoops	14 0 0	to 15 0 0
Marked bars (Staffs.) f.o.t. ..	14 0 0	
Gas strip	12 10 0	to 12 15 0
Bolts and nuts .. ¾ in. × 4 in. ..	16 15 0	

Steel—	£ s. d.	£ s. d.
Ship plates	7 5 0	to 7 17 6
Boiler plts. ..	11 10 0	
Chequer plts.	£9 5 0	to 9 15 0
Angles	£6 17 6	to 7 5 0
Tees	£8 0 0	to 8 5 0
Channels	£6 12 6	to 7 2 6
Joists	£6 17 6	to 7 5 0
Rounds and Squares 3 in. to 5½ ins. ..	8 0 0	
Rounds under 3 in. to ⅜ in.	7 15 0	
Flats, over 5 in. wide and up ..	8 10 0	
Flats, 5in. to 1½in.	7 10 0	
Rails, heavy ..	8 0 0	
Fishplates	12 0 0	
Hoops (Staffs.) ..	10 10 0	
Black sheets, 24g.	11 5 0	
Galv. cor. sheets, 24g.	16 15 0	
Galv. fencing wire 8g. plain	14 0 0	
Billets, soft	£6 0 0	to 7 5 0
Billets, hard ..	8 2 6	
Sheet bars	6 5 0	
Tin bars d/d	6 5 0	

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3¾
Rods	1	3
Tubes	1	8½
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/– to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	24.26
No. 2 foundry, Valley	22.26
No. 2 foundry, Birm.	22.00
Basic	21.76
Bessemer	22.76
Malleable	22.26
Grey forge	21.76
Ferro-mang. 80% d/d	115.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 28 ..	3.35
Sheets, galv., No. 28 ..	4.60
Sheets, blue an'l'd, 9 & 10	2.50
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry ..	32/6 to 37/6
,, furnace ..	20/– to 25/–
Durham & North.	
,, foundry	30/– to 33/–
,, furnace ..	18/6
Other Districts, foundry	30/– to 33/–
,, ,, furnace (basis)	11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	19/9
,,	28×20, ,,	39/6
,,	20×10, ,,	29/1½
,,	18¾×14, ,,	20/6
C.W.	20×14, ,,	18/3
,,	28×20, ,,	36/1½
,,	20×10, ,,	24/10½
,,	18¾×14, ,,	18/7½

Terneplates 28×20, 36/1½ per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£19/0 to £20/0
Rolled Ord.	£16/0/0 to £16/10/0
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 15 0 to £7 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes	*Fittings*
Gas	60%	50%
Water	55%	45%
Steam	50%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.		
Jan. 7	59	5	0	dec.	5/–
„ 8	59	7	6	inc.	2/6
„ 11	59	10	0	„	2/6
„ 12	59	15	0	„	5/–
„ 13	59	10	0	dec.	5/–

Electrolytic Copper.

	£	s.	d.		
Jan. 7	65	10	0	No change	
„ 8	65	10	0	„	„
„ 11	65	10	0	„	„
„ 12	66	0	0	inc.	10/–
„ 13	66	0	0	No change	

Standard Tin (Cash).

	£	s.	d.		
Jan. 7	285	5	0	dec.	55/–
„ 8	285	5	0	No change	
„ 11	283	5	0	dec.	40/–
„ 12	285	10	0	inc.	45/–
„ 13	287	0	0	„	30/–

Tin (English ingots).

	£	s.	d.		
Jan. 7	284	0	0	dec.	60/–
„ 8	284	5	0	inc.	5/–
„ 11	282	0	0	dec.	45/–
„ 12	284	5	0	inc.	45/–
„ 13	285	10	0	„	25/–

Zinc Sheets (English).

	£	s.	d.		
Jan. 7	46	0	0	No change	
„ 8	46	0	0	„	„
„ 11	46	0	0	„	„
„ 12	46	0	0	„	„
„ 13	46	0	0	„	„

Spelter (ordinary).

	£	s.	d.		
Jan. 7	38	16	3	inc.	1/3
„ 8	39	3	9	„	7/6
„ 11	38	18	9	dec.	5/–
„ 12	38	13	9	„	5/–
„ 13	38	15	0	inc.	1/3

Lead (English).

	£	s.	d.		
Jan. 7	36	5	0	dec.	10/–
„ 8	36	5	0	No change	
„ 11	36	5	0	„	„
„ 12	36	10	0	inc.	5/–
„ 13	36	10	0	No change	

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS.

Year.	Jan	Feb	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1885	44 0	44 1	43 2	43 1	42 10	42 6	42 6	42 0	42 2	42 1	43 0	43 8	42 11½
1886	43 3½	42 0	42 0	41 6½	41 2½	40 0	40 0	41 2½	41 6	44 0	44 0	44 9	42 2½
1887	49 6	48 9½	45 6	43 2½	43 6½	44 1	44 0	44 2½	43 5½	41 6	41 9½	45 0	44 0½
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	49 10½	48 8½	46 10	46 1½	48 2½
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 0	88 9½	94 3½

WILLIAM JACKS & COMPANY,

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OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR
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P.O. BOX 1580, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

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93, HOPE STREET, GLASGOW.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

SITUATIONS VACANT AND WANTED.

FOREMAN ROLL MAKER seeks situation; first-class practical and technical experience in all classes of grain and chilled rolls, also melting in air furnaces and cupolas, mixing of metals by analysis, etc.; first-class references.—Box 596, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

STEEL FOUNDRY MANAGER; disengaged; experienced with the following plants: Siemens, Tropenas, Stock Oil Converter, and eight years' experience with the Electric Furnace Process; understanding the manufacture of Steel Castings from A to Z at a very keen cost of production, either piecework or time-work; having also a fair connection; excellent references.—Box 568, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN wanted, London district.—Write, stating experience, Box 584, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN wanted by firm of Malleable Ironfounders in the Midlands; must have had extensive experience in machine moulding and cupola practice, and be a thoroughly energetic man. State age, experience and salary required.—Box 588, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PARTNERSHIPS.

GENTLEMAN can introduce capital from clients £2-5,000 for Limited Companies, etc., as active or non-active Directors; fee on completion.—Box 586, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY

PLANERS.

One Louden HORIZONTAL PLANING MACHINE, to take 8 ft. x 4 ft. x 3 ft. 6 in.; quick return motion; very good condition; for Sale, cheap.—Write Box 590, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

DRILLING AND BORING MACHINES.

One Horizontal DRILLING AND TAPPING MACHINE; spindle, 3½ in. diameter x 14 in.; standard, 5 ft. high; T-slotted Table, 3 ft. x 3 ft.; in addition, Swivelling Table on top, 3 ft. x 3 ft. x 4½ in. deep; modern tool; by Tullis.

One Horizontal BORING MACHINE, Noble & Lund; standard, 6 ft. high; spindle, 3½ in. diameter; Slotted Bed in front, 14 ft. x 6 ft.; in excellent condition.

One Horizontal BORING AND FACING MACHINE, by Noble & Lund; to face 36 in.; Rising and Falling Bed, 5 ft. x 2 ft. 6 in.; Saddle on top of bed, with T-slotted Table, 3 ft. x 2 ft. 9 in.; excellent condition.

For prices and further particulars, write Box 592, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

VERTICAL AND HORIZONTAL PLANING MACHINE OR CREEPER.

To plane 10 ft. x 10 ft., complete with vertical column and saddle, with two tool boxes; Cross Bed, 17 ft. long x 3 ft. 6 in.; Self-acting Slotted Table, 10 ft. 6 in. x 4 ft. 3 in.; also Slotted Bed, 5 ft. x 4 ft. 6 in.; Detachable Table, 5 ft. 3 in. x 2 ft. 2 in. x 2 ft. 6 in.; large, massive tool, in very good condition; for Sale cheap.—Write Box 594, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY.—*Continued.*

"OLIVER." No. 75. MECHANICAL PATTERN MAKER, and Universal Wood Milling Machine, second-hand, but having had little use, is equal to new, complete with full set of tools, accessories, etc.; great bargain at very low price; photo.—Apply, FRED BROWN & SON, LIMITED, North Road Works, St. Helens.

WANTED, 4-Morgan Tilting Furnaces, 800 or 1,000 lbs. capacity; oil or gas fired.—Box 574, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOR SALE.—20-in. and 24-in. Hall's Invincible Sand Mixers; the original and best machine in the market for mixing old and new Foundry Sand, Coal Dust, etc.—Apply, PENNEY & PORTER (ENG.), LTD., Lincoln.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LTD., Russell Street, Sheffield.

MACHINERY, PLANT, &c.

18-in. centre SLIDING AND SURFACING BREAK LATHE, by Pollock & Macnab, swing 19 ft. between centre, 13 ft. in gap.

Two 40-in. DUPLEX BORING AND TURNING MILLS, with swivel turret heads and gear-box drive.

No. 70 INTERNAL GRINDING MACHINE, by Heald Machine Co., capacity 15-in. swing, 11 in. long.

RACK-DRIVEN PLANING MACHINE, to plane 8 ft. x 2 ft. 6 in. x 2 ft. 6 in., one tool box, by American Tool Works.

LANCASHIRE BOILER, 26 ft. x 6 ft. 6 in. diameter, reinsure 100 lbs. pressure.

VERTICAL MULTITUBULAR BOILER, 7 ft. 9 in. x 3 ft. 6 in. diameter, reinsure 100 lbs. pressure.

CATALOGUE (10,000 LOTS) ON APPLICATION.

THOS W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

TINPLATE CUTTINGS.—Buyers are requested to send their best price for bright new tin cuttings to T. P. C., c/o E. M HARVEY, 8, Broad Court Chambers, Bow Street, W.C.2.

FOUNDRY wanted to make and finish Cast Household line; competitive price; good quantities involved.—Apply, Box 578, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

THE MOULDER'S SURE GUIDE TO SUCCESS.—"The Foundryman's Educator," by Arthur Greaves; 6s., post free.—EDWARDS & BRYNING, LIMITED, Rochdale.

LETTERS AND FIGURES for Patterns; all sizes; Aluminium; die cast, with pins in one piece; no shellac needed; simply drive them in and they cannot come off. Send for samples and prices.—A. LAKIN & SON, Totley Rise, Sheffield.

MOULDING MACHINES.

Two NEW 40" × 50" OSBORN J405 Rollover Jolters (unused machines) .. .. each £250
Two 18" × 36" TABOR Portable Shockless Rollover Jolters (practically new) .. each £90
Two nearly new 14" × 16" TABOR Power Draft Squeezers, warranted perfect order .. each £60
Two No. 2 DENBIGH Jolters .. .. .. each £18
Two No. 1 DENBIGH Jolters .. .. .. each £15

NEW LADLES—CHEAP.

12 Ton EVANS £95
3 Ton THWAITES £32
2 Ton THWAITES £26
1½ Ton EVANS £21

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND,
FOUNDRY MACHINERY MERCHANT,
"BOXTED," SLOUGH.